THE

ELECTRICAL REVIEW.

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THE

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STORAGE BATTERY TESTING EXTRAORDINARY.

WE have received a copy of a most extraordinary report made on the storage battery manufactured by the International Electric Storage Company, Limited. This we have printed in another column.

The report is made by Mr. Cuthbert Hall, and is so peculiar in many respects, that, regarded as an attempt at a scientific report, it calls for some comment.

In the first place the methods employed in the tests to ascertain the figures, such as they are, are not even hinted at; the size of the battery tested is merely given, and then, without any further particulars, the statement is made—(*a*) That the battery was discharged "at a rate $6\frac{1}{4}$ times (observe the vulgar fraction) the maximum rate of an E.P.S. cell;" but the size or type of E.P.S. cell referred to is left to one's own imagination. Then we are informed that the capacity was "3·4 times as great as would be obtained from an E.P.S. cell," and here we have the figure given in decimals; but again no mention of the dimensions of the E.P.S. cell, except that the maximum rate of the E.P.S. cell discharge is $\frac{1}{6\cdot25}$ that of the I.E.S. battery. What a nice little mixture of figures; first we get vulgar fractions, then decimals, and finally a combination of both.

Such jargon as this is absolutely meaningless without the statements of actual discharges, volts, ampères and time; and no such extraordinary comparisons between one cell and another can be tolerated, unless the actual readings and measurements are recorded and published: everybody could then make the comparisons for themselves.

To take a standard type of cell such as the E.P.S., and compare its commercially rated maximum discharge with an arbitrarily chosen rate of discharge of another cell, is neither a fair nor reasonable method of testing. The E.P.S. cells, or any cells, can be discharged at ten times their rated discharge for some considerable time without apparent injury, and there is absolutely no proof in this report to show that the I.E.S. cells were not damaged by the "$8\frac{3}{4}$ times the E.P.S. rate of discharge."

Why should the cell of the I.E.S. Company be compared with any other in this reckless manner? Why did not Mr. Cuthbert Hall give us a plain unvarnished account of his tests, with a column or two of his results in figures?

On the question of capacities we are pleased to note that this expert confesses his inability to make comparisons, but we must protest against the assertion that the "E.P.S. cell would not stand such heavy discharges." "And if they were employed much lower capacities would result."

In the absence of reliable tests and properly ascertained figures, we cannot allow such unsupported statements to go unchallenged.

The E.P.S. Company is quite able to take care of itself

and its wares, so we do not criticise this precious report in the interest of this or any other cell; we only wish to draw attention to the manner in which attempts are made by so-called expert reports to foist on the public a certain manufacture, and we could not have imagined a better for our purpose than this one now before us. It would admirably "point a moral or adorn a tale" relating to the art of scientific testing and reporting on inventions, and it is from this point of view that the report is worth calling attention to. The statements and figures in it are so transparently erroneous and reckless, we can scarcely believe they would be accepted even if we published them without comment. As a model of what a report on battery testing should not be, the document is probably unique, and can best be classed as a literary and scientific curiosity. As a report, it is enough to damn the prospects of any invention; it is so obviously an instance of "no case, blacken the characters on the other side," as practised by some "limbs of the law."

THE ELECTRIC SPARK.

M. Farman shows in *L'Energie Electrique* some interesting photographs of electric sparks which he has obtained by allowing the discharge from the poles of a Wimshurst machine to flash on to the sensitive surface of a photographic plate. In his experiments he used a very simple apparatus. A plate of copper, of less size than the photographic plate, was supported in a horizontal position by a glass rod; the surface of the copper plate was covered with a sheet of black paper to prevent reflection, and over this the photographic plate was placed with its sensitive surface upwards. One pole of the Wimshurst machine was connected to earth and the other brought over the centre of the photographic plate. The pointed end of a discharging rod was now brought in contact with the centre of the plate, while the other end was gradually approached to the pole of the machine till a spark passed. A marked difference appears in the photographs obtained, according as the discharge is from a positive or a negative pole. The discharge from the positive pole is very much bent and ramified, while that from the negative pole shows a less number of more uniformly curved branches. M. Farman considers that these photographs point to a one-fluid theory of electricity, the positive pole having a higher pressure and the negative pole a lower pressure than the surrounding medium. It is to be expected that the lines of flow would be different in the two cases. Photographs of electric sparks have often, before this, been obtained by discharging on to the sensitive surface of a photographic plate, but it appears to us to be by no means a good method of investigating the nature of the electric spark. The discharge takes place, partly, at least, through such complex materials as a mixture of gelatine and bromide of silver, which makes the phenomenon a very complicated one. We are likely to learn far more from photographs of sparks discharged through gases, or other simple bodies.

Another experimenter, Mr. Hanchett, has conceived the novel idea of applying the microscope to the examination of the disruptive discharge.* The discharge was arranged to take place between the pointed ends of two strips of tinfoil pasted on a microscope slide. One of the strips was put to earth through the microscope stand, while the other was connected to a terminal of an induction coil, of which the other pole was put to earth. A common push button served to open and close the primary circuit at pleasure. It was noticed that the tinfoil terminals were rapidly diminished in size, if the discharge was at all strong, but the most interesting point noted was that the *negative* terminal wasted away the more rapidly—the exact reverse of what occurs in the voltaic arc. The destruction of the negative terminal was evidently due to its being melted by heat, while that of the positive appeared to be of a mechanical nature, the particles being rather torn off than melted into a knob. An experiment was made to find whether there was any loss of weight in the tinfoil terminals after a heavy discharge, but none could be detected by the chemical balance. A glass fibre was placed across the path of the discharge to ascertain whether there was any mechanical force in either direction, but again with negative results. Mr. Hanchett made several photographs of the appearance of the spark under the microscope, which, however, do not appear to have revealed anything novel. This line of investigation, we think, is promising, and deserves to be more extensively employed.

* *Electrical World*, March 30th, 1895.

High v. Low Tension.

Mr. J. C. Howell, of Llanelly, has, in the *South Wales Daily Post*, been criticising the report on electric lighting presented by Mr. Manville to the Corporation of Swansea, and adopted by them. Apparently, Mr. Howell does not approve of any system of electric lighting being adopted which does not involve the use of accumulators, and his written statements to this effect caused Mr. Manville to point out that as this gentleman is largely interested in the manufacture of accumulators, his opinion upon that matter was not an impartial one, and that decisions as to the system to be employed in a particular town were better left to those who had no trade interests. This was met by a letter from Mr. Howell, in which he makes statements that will certainly be regarded in the light of news to our readers, for Mr. Howell contends it is a notorious fact that in order to make both ends meet, alternating high tension stations only provide a supply to their customers from dusk to midnight or a little after, and scarcely a week passes in which Mr. Howell does not have some record of the partial or total breakdown of the lighting in places where this system is used, and in Mr. Howell's opinion, these unfortunate records have retarded the progress of electric lighting in this country more than anything else. Mr. Howell is so affected by the prospects of disaster that will ensue if the Swansea Council carry into effect Mr. Manville's recommendation, that he proposes as a ratepayer in Swansea to call a meeting of the ratepayers to protest. Mr. Howell, in a further letter, contends that he has taken the matter up because he lives in that district, and is anxious to see electric lighting succeed in the way it would if competent engineers were consulted by town councils, and he is determined to do all he can to prevent certain disaster falling on the town of Swansea. We certainly see no objection to any amount of fair comments on matters of this kind, but we must distinctly protest against statements being uttered as facts, thereby imposing upon readers of local papers who have small means of judging for themselves the veracity or otherwise, of such statements. So far from it being a notorious fact that high tension stations constantly break down and only provide light for a few

hours a day, it is, as is evident to all our readers, a fact that the headway being made by this system in supplying districts that could not be profitably supplied by a low tension system is considerable and most encouraging, and the services given by such stations is in many cases preferable to that given by low tension stations, by the maintenance of a more even pressure for its distribution mains. As to the competency or incompetency of Mr. Manville, this gentleman being well-known to most of our readers, our opinion is not called for.

Nickel-steel Wire.

The remarkable results of the addition of a small percentage of nickel to steel are pretty well known. Nickel-steel armour plates and nickel-steel shot are among the wonders of the age. What perhaps is not so well known is the fact that the effects vary with the proportion of nickel introduced, while a small proportion produces an alloy of extraordinary hardness, a larger proportion produces great toughness, thus the propeller shafts of the latest American men-of-war are of nickel-steel, and are considerably lighter and stronger than if they were constructed of the very best ordinary steel. The non-corroding qualities of the alloy are among its most valuable when used for marine purposes. The United States navy are using it for torpedo-defence netting, and a sample of the wire containing 27·8 per cent. of nickel is stated as having stood the following tests :—Diameter, 0·116 inches; breaking strain, 2,100 lbs., or nearly 89 tons to the square inch, when calculated on the reduced area of the break; elongation, 6·25 per cent. The price of nickel has fallen from 24s. a pound to 1s. 2d. at the present time. Submarine cable owners should not let this matter escape their notice. If a wire which is practically non-corrosive and as strong as the best steel can be produced, there is no reason why the life of a cable should not be enormously prolonged. We should like to see an experimental length of cable made with nickel-steel wire laid down to test its non-corrodibility. The galvanising of the iron or steel wire as ordinarily employed is at the best a very temporary preservative. If any imperfections exist in the galvanisation the wire corrodes more rapidly than before, and we should not be surprised if a good deal of the pitting and even the wearing away of the wires to needlepoints, sometimes noticed in old cables and usually attributed to the chemical action of the ground on which they rest, is due to this cause. We have never yet heard of the galvanising of the wires employed for submarine cables being tested in any other way than by three or four successive dippings in a saturated solution of sulphate of copper at 60° F. The Post Office, however, requires that for aerial purposes the wire shall be capable of withstanding repeated bendings round bars of from 1½ to 2½ inches in diameter without the zinc coating exhibiting any signs of cracking or peeling. The weight of zinc employed to galvanise a small wire is considerable in proportion to that of the wire, and since the zinc does not to any appreciable extent add to the strength, it is so much dead loss from this point of view. Thus a steel wire of 0·092 inch diameter, having a breaking strain of 100 tons to the square inch, will support about 12·5 miles of itself in sea-water: when galvanised, however, this so-called modulus of tension becomes reduced to about 11·4 miles.

A Carbon Iron Element.

One of the earliest attempts to obtain an electric current directly from the consumption of carbon was made by Jablochkoff by immersing a carbon electrode in a bath of melted saltpetre. The interest excited by Dr. Borchers's recent experiments has induced* Mr. G. Schmitz, of Dresden, to reinvestigate Jablochkoff's method. A mixture of potassium and sodium nitrates was melted in an iron crucible. Into the bath of melted nitrates were dipped rods of different kinds of carbon. The crucible formed the cathode, and the carbon the anode, of the battery, as was shown by the direction of the current when they were connected up. Limewood charcoal, anthracite, gas coal, lamp carbon, and graphite, were tried in the battery. The first three materials were found to be unsuitable because they caught fire when immersed in the bath of melted saltpetre. Graphite behaved in exactly the opposite way; no chemical reaction or perceptible current was shown. The experiment with the lamp carbon, however, was much more satisfactory. It did not ignite in saltpetre heated to a temperature of 800°. At 400 to 500°, however, there was a considerable development of gas, which notably increased when the circuit was closed. A weak but steady current with a pressure of 1 volt was produced. The iron of the crucible was not perceptibly attacked, and the heat produced by the combustion of the carbon was very small. The success of this battery evidently depends on the physical constitution of the carbon, and as saltpetre is cheap, and a cheap suitable form of carbon may yet be produced, perhaps Jablochkoff's method may not be altogether without some future hope.

* *Electrotechnische Zeitschrift*, Vol. xvi., p. 145.

Electrostatic Capacities.

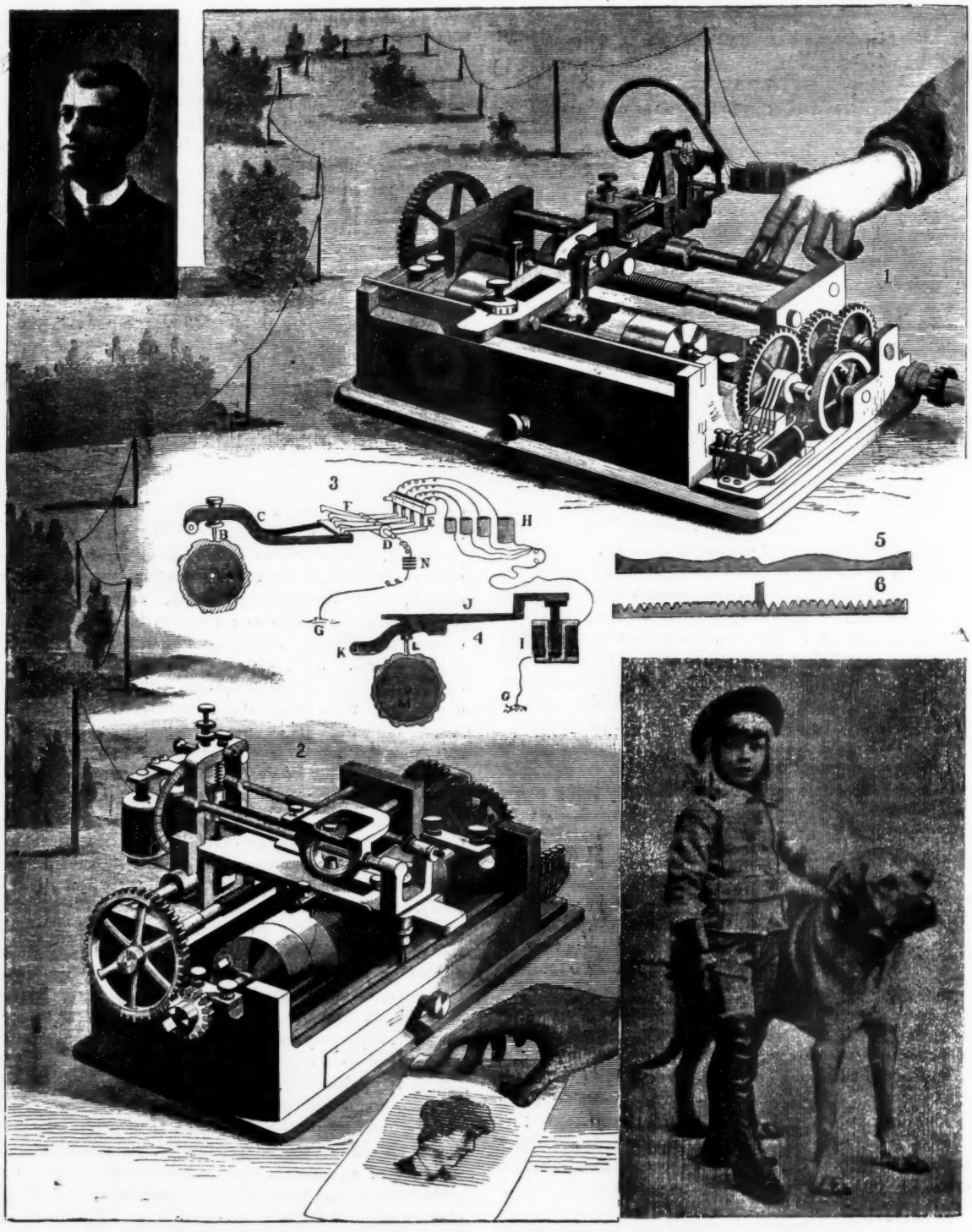
We are in possession of a copy of a paper by Prof. Francis E. Nipher, read before the Academy of Science of St. Louis, on "The Electrical Capacity of Bodies and the energy of an Electrical Charge." It appears to be a fairly creditable and in some respects a helpful contribution. But we notice in the first paragraph, from which the succeeding inferences are mathematically deduced, an error which, though perhaps common enough, claims our serious attention. It is said that the lines of force or induction around an electrified body distribute themselves as if space offered resistance to their passage. This is not the case. Take, for instance, a hollow spherical conductor with a not over large opening into its interior. Such a conductor when charged and insulated in space is to all intents and purposes absolutely devoid of charge on its inner surface except close around the opening. Immerse the same conductor in a conducting fluid and make it an electrode by connecting it to a current source, the other electrode being, say, the containing vessel. We imagine that quite an appreciable amount of the total current will flow from the inside surface of the sphere showing an essential difference in the distribution of the lines of induction and current flow respectively. Neither could the discharging effect of points be properly accounted for on this resistance basis. In fact, the analogy fails wherever the shape of the body causes a want of uniformity in the surface density. Those few cases, however, which are treated by Prof. Nipher, certainly conform to the analogy, and his results are, therefore, apparently correct. The convenient statement that difference of electric potentials produces electrostatic induction is very misleading, for it gives the impression that the electrification of the bodies is, as it were, the primary or initial effect, and the propagation of lines of induction the result. If we mistake not, the author, himself, has this view when he speaks of an apparent reaction between the electrification and a stressed condition which is impressed upon each element of the medium in reducing the area of an electrified surface. On the contrary, and there is every reason for the statement, the stressed or rather strained condition of the medium is undoubtedly the cause of the difference of potentials, or rather, the latter expression simply means that a state of electrical strain prevails. The term "lines of induction" is also open to objection in this sense, for induction implies a resultant rather than an initial effect.

THE AMSTUTZ ELECTRO-ARTOGRAPH.*

The advent of each year is made attractive by the development of some new and useful invention for the use of humanity, or, possibly, by the improvement of what was supposed to be an already perfected idea. That improvements in the general use of the electrical current would continue was naturally to be expected, considering the greater knowledge of its laws each year brings to the engineer who makes a study of this marvellous agency.

When the telephone was introduced to the attention of the world, and the human voice was made audible miles away, and also when the phonograph, with its capabilities of storing up the human voice, was made public, there were dreamy visions of other combinations of natural forces by which even sight might be obtained of distant scenes through inanimate wire.

It may be claimed, now, that though we do not see an object miles distant through the wire, yet this same inanimate wire and electrical current will soon serve us, automatically, as both artist and engraver, transmitting and engraving at the same time a copy of a photograph miles away from the original.



Mr. N. S. Amstutz, a well-known mechanical and electrical engineer of Cleveland, Ohio, has brought out of the elements an invention by which this is accomplished. As will be seen by the workings described, it might appro

* *Scientific American.*

priately be termed a marriage of the phonograph and telephone, as the features of these two inventions are allied in this, called by Mr. Amstutz, electro-artograph. The object of the invention is to transmit copies of photographs to any distance, and reproduce the same at the other end of the wire, in line engraving, ready for press printing.

The undulatory or wave current is used, as in the telephone, while the reproduction is made upon a synchronously revolving, waxed cylinder, as in the phonograph. There is required for this end both a transmitting and receiving instrument, views of each of which are shown in our illustrations, from sketches made from the instruments in use by Mr. Amstutz.

The principle by which this work is accomplished is quite simple, and will readily be understood by reference to the diagrams shown, fig. 3 representing the transmitter and fig. 4 the receiver.

An ordinary photographic negative is made of the subject to be transmitted; an exposure is made under this negative of a film of gelatine, sensitised with bichromate of potash, and by which the effect is produced of rendering insoluble in water the parts exposed to the light passing through the thin portions of the negative, while those portions protected from the action of the light can be dissolved away; the capabilities of dissolving away varying with the intensity of shade or light upon the negative. After dissolving away the soluble portions from the film there will remain the same picture as appeared on the negative, but it will be entirely in relief. We show a section of such a film, exaggerated, in fig. 5, in which the variations upon the surface represent the varying effects of the light and shade of the picture.

The film is now attached to the surface of the cylinder, A, fig. 3, and caused to revolve; a tracer or point, B, adjustably connected to a lever, C, rests upon the film, and as the film revolves, rises and falls with the undulating surface of the

The above block reproduced from an article in the Electrical Review of December 4th, 1891, on this invention, will, when compared with the blocks on the foregoing page, show the improvement effected by Mr. Amstutz.

film and communicating an up and down movement of the end of the lever, C, in a multiplied degree. A number of tappets or levers, F, are centrally fulcrumed at D, and arranged so that one end presses upward on the lower end of terminals, E; the opposite ends of the tappets varying in distance from a horizontal line over the end of the lever, C, as shown. When the lever, C, is at its lowest point, as influenced by a depression in the gelatine film, all the tappets press up against the terminals; with a further revolution of the cylinder, A, and an elevation in the film forcing the lever, C, upward, all of the tappets' contact with the terminals, except one, is broken. The height of the hill and depth of valley of the film's surface measuring the number of tappets in contact with the terminals.

One terminal of a battery, N, is grounded, and the other is connected to the fulcrum, D, of the tappets, F, and the current passes through the tappets, F, terminals, E, and resistance, H, to the main line wire, and thence on to the distant solenoid, I, at the receiving end, and to the ground. When all of the tappets touch the terminals, all the resistances are in parallel and the total resistance is least and the current greatest; and *vice versa*, resistance greatest and current least as the number of tappets' contact are broken. By this arrangement of the resistances, there are hills and valleys in the current corresponding to those on the film's surface. This variable current, circulating around the solenoid, I, produces a varying pull on the core attached to the end of the lever, J. This lever is fulcrumed at K. A diamond or V shaped cutter, L, is attached to the lever, beneath which is a plain gelatine or wax film attached to the cylinder, M.

With this arrangement in mind, it will readily be seen that with one revolution of the cylinder, A, as the tracer follows the elevations and depressions upon the film, the free end of the lever, C, is made to contact with the ends of one or more of the tappets, permitting more or less of a current to pass through the resistance, and exerting thereby more or less of a downward pull on the end of the lever, J.

We have shown but four of these tappets for simplicity, but it will readily be seen that the greater the number, the more delicate will the variations be of the pull on the core of the solenoid. The number is not limited, but Mr. Amstutz finds not more than ten as being all that would be required, while for the bold work required for newspaper printing, a much less number would be better.

Supposing now that a relief plate or film has been fastened upon the transmitting cylinder, A, and a smooth film of gelatine or wax upon the receiving cylinder, M, and both are revolved at the same speed. One revolution would cause the V tool, L, to cut a line around the film, irregular in its depths and widths, caused by the varying pull on the lever's end by the core of the solenoid. A picture is not made, however, by one line, but one line is, however, an element of a whole picture, so, as the cylinder revolves, the tracer and the V tool are moved along by the screw shown in figs. 1 and 2, and, spirally, another line is produced by the side of the first one, with varying depths and widths of cut, fig. 6, corresponding to the neighbouring waves of surface on the film. The lines are thus continued over the film from end to end, and when the film on the cylinder is electrotyped it is ready to be printed from.

The two machines which we show in figs. 1 and 2 have the same general characteristics: A mounting frame, a travelling tracer and graver carriage, guided by the round bar at the back and moved forward over the cylinder by the screw in front of the guiding bar, a rotating cylinder corresponding to the cylinders, A and M, suitable gearing at the ends for revolving the cylinder and screw, the necessary adjusting screws and nuts and a synchronising device for governing the speed of each cylinder.

With the perfection of detail which is now the work of Mr. Amstutz, the class of engraving done by this method will be of the highest order of art—line engraving. The work it accomplishes is not confined in its scope to gelatine, but designs may be chased and engraved also upon the metals, as gold and silver ware. Neither is it necessarily a long distance or line operator, for the machines may be placed side by side and local work can be accomplished.

We have selected two examples of the work done by these machines in their present form, which will convey to the intelligent critic a faint idea of the artistic capabilities it can be made to display when its future perfection of detail is accomplished. Both the portrait of the inventor and the view of the boy and dog were engraved upon these machines in the private laboratory of Mr. Amstutz, the time required in engraving the latter being but three minutes.

It is not difficult to believe that in the future events which may take place in London or Paris may be sent from photos taken in Europe, and the reproduction of the same, in an artistic picture, appear in the next morning's New York or Chicago papers; and this without disturbing the existing conditions of telegraphic communication further than supplying the two offices each with machines for transmitting and receiving.

Mr. Amstutz has had practical experience with and is familiar with the general requirements for illustrative work, and is conversant with the limitations of art work as used in book and newspaper printing. In consequence, he has been better enabled to cope with all the difficulties and overcome them in these machines. Improvements, however, are now in progress, principally to give greater expedition, and to render either continuous or alternating currents applicable—the same principle, however, being the foundation.

We are under obligations to Mr. Amstutz for the opportunity to present these, the first sketches ever made from these machines, and courteously permitting us to lay all this

interesting subject, in a complete form, before our readers. Mr. Amstutz has signified his willingness to answer such correspondents as may, briefly, desire further information.

AN AMERICAN ELECTRIC RAILWAY.

The event for which electricians throughout the States are waiting with impatient interest—the operation of passenger and freight trains on the Belt Line tunnel of the Baltimore and Ohio Railroad, at Baltimore, by locomotives in which the sole propulsive power will be electricity, is now nearing realisation. Work has been progressing steadily lately at the works of the General Electric Company, both upon the generating plant and the locomotives, and the early part of this new year will probably see the huge locomotives handling the long trains with the ease for which they are designed. This experiment will be the first practical step in that country toward the subjection of the steam trunk railroad to electricity. Two comparatively small locomotives, one of 30 tons and the other of 40 tons on the drivers, are already running but not upon any important lines, and, while perfectly successful, their operation gives but little clue to the outcome of the practical tests on the Baltimore and Ohio Road. The delay that has occurred in the completion of the work has been of advantage in that it has allowed of the embodiment in this apparatus of all the recent improvements in electric railway practice.

The trucks are of forged iron, each resting upon four driving wheels of cast steel 62 inches in diameter. Flexibly supported upon each of these trucks are two six-pole gearless motors, one for each axle, transmitting their motion from the armatures to the wheels by means of an especially designed flexible coupling. The method of spring suspension has been carefully modified to allow of the immediate adjustment of the wheels to the irregularities of the tracks, and thus effect a diminution in the wear both to the motors and the track. The massive armatures are of the ironclad type. A hollow shaft serves to carry the armature, and through this passes the wheel axle, to which it is connected by the universal coupling already mentioned, which allows of freedom of movement in any direction.

The complete motors are the largest railway motors in the world, and while ponderous in appearance are by no means so bulky as might be expected from the heavy duty they will be called upon to perform. They are so set on the truck that they will be easy of access under all circumstances, whether the locomotive is at a standstill or in motion.

The cab, which will be spring supported on the truck frame will be of sheet iron and wood, and will have windows on all sides in order that the occupants may have an unobstructed view in all directions. Within the cab will be set up the series parallel controller by means of which the movement of the locomotive will be at the command of the driver, and the air pump, operated by a small electric motor, which will supply the air for the compressed air brakes and the whistle. The locomotive will be also equipped with bells, safety devices, &c., and will have a Janney automatic coupler at each end.

The finished locomotive will be an imposing piece of electrical machinery. It will weigh in its completed state 95 tons, will be 14 feet 3 inches long, 9 feet 6¾ inches wide, and will be of standard gauge. The maximum speed will be 50 miles an hour. This will be reduced to 30 miles an hour when only half the draw-bar pull is exerted, and to 15 miles an hour with full draw-bar pull. The average speed of the loaded train will be about 30 miles an hour. It can, of course, be run either forward or backward.

This locomotive is designed for heavy work, and will be called upon to handle trains as heavy as those now handled by the heaviest steam locomotives. A test of one of the completed trucks, representing one-half of the locomotive, was recently made upon the tracks at the Schenectady Works of the Construction Company. In order to obtain the necessary load, a New York central heavy six-wheel engine was made use of and the electric locomotive truck coupled to it. The machines were then sent in opposite directions and tugged at the connecting coupling as in a tug of war. The electric locomotive had a slight advantage over the steam engine in weight on the driving wheels, and pulled it up and down the track with apparent ease. For the same weight upon the drivers it was shown that the electric locomotive will start a greater load than the steam locomotive, the pull being constant throughout the entire revolution of the wheel, the difficulty of variation of pull with the angle crank, as in the steam locomotive, being eliminated. The test also proved that not only were the motors sufficiently powerful, but that the driving mechanism and armature couplings are amply strong to transmit the torque of the armature to the axle.

The power house is rapidly nearing completion, and the generating machinery is almost ready for installation. The overhead apparatus, which has been especially designed to meet the extraordinary requirements, will shortly be in position, and before many months have passed the steam locomotive will have become a neutral object in the operation of trains in the Belt Line tunnel which, tarnished by smoke and soot, will be brilliantly lighted by incandescent lamps. A great step will have been made toward more general electrical locomotion, and steam roads and the travelling public will have entered upon a new era.

ALTERNATING AND INTERRUPTED ELECTRIC CURRENTS.

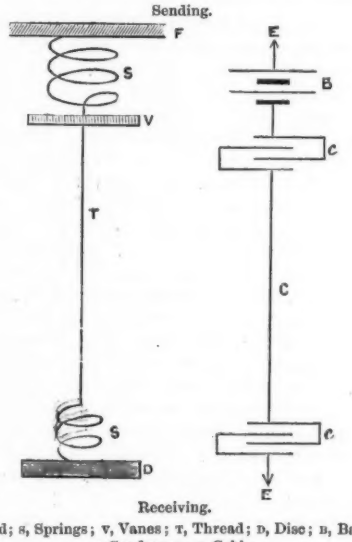
I.

Prof. George Forbes is engaged in the delivery of a course of three lectures on alternating and interrupted electric currents at the Royal Institution on Tuesday afternoons. The first of the series was delivered last Tuesday, and was principally devoted to a consideration of the effects of interrupted and alternating currents as distinguished from continuous currents. Prof. Forbes acknowledged his indebtedness to Dr. Muirhead for the ability to show the retardation which occurs when a signal is sent on a real Atlantic cable—or what is the exact counterpart of an actual cable electrically. The action which takes place when a current is sent through an Atlantic cable has, the lecturer considers, been buried amongst the obscurity of mathematical symbols. The feeling left on our mind after the lecture was over was, however, that useful as are mechanical analogues in the explanation of the effects of capacity and inductance with alternating or intermittent currents, they fail to give a complete and useful conception of the actions taking place. It will be seen that Prof. Forbes introduces some extremely beautiful contrivances to give the uninitiated listener some idea of what is meant by retardation, &c. No doubt a Royal Institution audience would not care to be treated to a rigorously exact mathematical examination of the results when capacity and inductance are present in a submarine or other cable, but one may be permitted to raise a word of protest against any attempt to depreciate the value of mathematics when applied to physical problems on a physical basis.

To return, however, to the more useful task of reporting what the professor did say: he held out the hope that by means of comparisons and analogues, "intelligent to anyone," some idea of the propagation of a signal or current wave might be given even to those unacquainted with electrical theory. When a battery is coupled to a cable a charge is being imparted to the outside, and that prevents the rapid passage of the current through the cable. By the aid of a mechanical analogy, one may try to grasp the idea and to make it intelligible to all. An excellent analogy is that so frequently used of the flow of water in pipes. A centrifugal pump may represent a dynamo, a pipe leading to and another from a water turbine take the place of electrical conductors, while the turbine itself occupies the place of an electric motor. The electrical pressure in the circuit is analogous to the water pressure in the other case, while the velocity acquired by the water represents the current. If instead of the turbine a pipe of much smaller bore than the main pipes be introduced, then at this point the maximum rate of energy dissipation takes place. This is similar to the circuit comprising a dynamo,

leads, and an incandescent lamp. On some rather obscure points this analogy fails, although for ordinary cases it is a very good one indeed. The method of propagation of electricity is comparatively simple and readily understood. It may be likened to the steel yard, in which it is "perfectly natural and obvious to you" that a small weight at the end of a long arm should balance a larger weight at the end of a shorter arm.* It is also very obvious to every person that a screw-press is an example of a mechanical device where a large motion of a small force may produce an immense pressure over a small distance. The best example, however, which can be cited of matter in motion is the gyrostat; it might be said, Why is it that the gyrostat does not twist in the direction that the force is impelling it? Very considerable thought would be required to make this clear. Again, an endless chain hung vertically over a motor pulley, and driven at a high speed, acts like a rigid body and goes through a series of motions, if displaced, which one would hardly have been likely to foresee. A paper disc weighted at the circumference and rapidly rotated in the vertical plane, also shows a phenomenon which, like those already mentioned, is dependent upon momentum. Electrical momentum usually goes by the name of self-induction, and capacity involves a certain pliability or flexibility of the chain representing the conductor. Capacity and self-induction are the two most interesting things which come into these lectures, and they will be dealt with pretty largely. Prof. Forbes had intended to show a beautiful experiment due to Faraday, which illustrated the preference of a Leyden jar discharge for the shortest path rather than for the path of lowest resistance, but circumstances prevented this being shown.

The torque or twist in a shaft could also be taken as analogous to a current in a conductor, and if the twist is periodically reversed, one obtains the analogue of an alternating current. To illustrate the effects of alternating cur-



F, Fixed; S, Springs; V, Vanes; T, Thread; D, Disc; B, Battery; C, Condenser; c, Cable.

rents, Prof. Forbes then performed Mr. A. A. C. Swinton's experiments, lighting an incandescent lamp which was connected between two metallic plates, these being held a short distance above another two plates of equal area, whose high-tension charges were reversed with extreme rapidity. A metal body brought near one of these plates drew a torrent of vivid sparks from it, while the lamp was equally well lighted when the lecturer's body was made the one plate of the condenser and a small mass of insulated metal the other. It is evident that Prof. Forbes does not accept Mr. Swinton's explanation of the manner in which the filament is caused to glow, as he distinctly stated that one-third of an ampère was flowing through the lamp. A number of simple, almost crude, but no less effective mechanical devices were used to illustrate the analogues of the electrical circuit in which pliability represented capacity and weight momentum; capacity may be taken as a yielding in the direction of the motion. "Many a curious thing has laid concealed in mathematics for many years, but appears comparatively simple when judged by the twisting analogy."

The most beautiful of all, however, are the mechanical and electrical analogues (shown in our illustration), in which a battery, condenser, cable, condenser and earth connections, are represented by a fixed point, a spring, a set of vanes, a thread moving in glycerine and water, a spring and a disc, to which the usual reflecting mirror is fixed. In each case the time taken to receive a signal is perfectly sensible; the retardation on the large Muirhead artificial cable and on the mechanical device described was shown by experiment. In practice, curbing is resorted to, and it was demonstrated that curbing sharpens up the signals very materially. Dr. Muirhead's curb sender and receiving mirror instruments were in use. This brought the lecture to a close.

* "Imagine a bar, the weight of which is neglected. The bar rests on a fulcrum. At equal distances from the fulcrum we append two weights. That the two weights, thus circumstanced, are in equilibrium, is the assumption from which Archimedes started. We might suppose that this was self-evident entirely apart from any experience, agreeably to the so-called principle of sufficient reason; that in view of the symmetry of the entire arrangement there is no reason why rotation should occur in the one direction rather than the other. But we forget in this that a great multitude of negative and positive experiences is implicity contained in our assumption; the negative, for instance, that dissimilar colours of the lever arms, the position of the spectator, an occurrence in the vicinity, and the like, exercise no influence; the positive, on the other hand, that (as it appears in the second assumption) not only the weights but also their distances from the supporting point are decisive factors in the disturbance of equilibrium, that they are also circumstances determinative of motion. By the aid of these experiences we do indeed perceive that rest (no motion) is the only motion which can be uniquely determined or defined (so as to leave only a single possibility open) by the determinative conditions of the case."—*Die Mechanik in irhre Entwickelung.* Mach.

CORRESPONDENCE.

The "Electrical Review" versus Spiritualism, Theosophy, "Electropathic" Belts, and Keelyism.

Ne sutor ultra crepidam.

An immense and, as yet, an almost unacknowledged debt of gratitude is due to the Review, not alone from the truth-seeker, but from every untaught individual who values his health and his money, for the part it has taken in exposing and crushing the gigantic and prosperous fraud in connection with "electropathic" belts. A smaller but yet not inconsiderable debt of gratitude is also due to that paper for its exposure of the pestilent and fraudulent form of quackery known as Keelyism, fortunately almost unknown in this country, but counting many dupes in America.

But it seems to me that some amends have been made to the exploiters of these two forms of swindling by the writer of the article "What is Electricity," on p. 443, who brackets them with *spiritualism* and *theosophy*. For if men, not only of the most unblemished character but of the very highest scientific standing have been and are witnesses on behalf of spiritualism, and if others, respected by the respected, are reverential votaries of theosophy, the inference is that "electropathic" belts and Keelyism may be upheld by the same class of people. This, I am sure, was not the writer's intention. I presume, therefore, that he was either ignorant of the facts of the case or that he is capable of arriving at the illogical conclusion that, because there have been and are a good many base two-shilling pieces in circulation, therefore the florin is a coin made of base metal.

What says Prof. F. Max Müller in his preface to the Gifford lectures delivered before the University of Glasgow?

"I ought, perhaps, to explain why, to the title of *Psychological Religion*, originally chosen for this my final course of Gifford lectures, I have added that of theosophy. It seemed to me that this venerable name, so well known among early Christian thinkers . . . has of late been so greatly misappropriated that it was high time to restore it to its proper function. It should be known once for all that one may call oneself a theosophist without being suspected of believing in spirit rappings, table-turnings, or any other occult sciences and black arts."

In speaking of theosophy, the professor does not mean *Blavatskyism*; perhaps your contributor does. It is amusing to notice that they both agree in their estimate of the phenomena of spiritualism.

In regard to the latter, Dr. Oliver J. Lodge has recently stated: "However the facts are to be explained, the possibility of the facts I am constrained to admit; there is no further room in my mind for doubt. Any person without invincible prejudice who had had the same experience would come to the same broad conclusion, viz.: that things hitherto held impossible do actually occur. . . . The phenomena do not seem to me to modify the fundamental laws of physics, but, perhaps, they may lead to an extension of the recognised laws of biology. . . . They (certain hypotheses) have at least aided my own mind to overcome some of its nausea at the reception of these unpalatable facts. Time achieves many things, and it may achieve the assimilation and digestion even of these tough morsels."

Such testimony is the more valuable from the fact that the witnesses do not, apparently, agree with Francis Bacon that "No pleasure is comparable to the standing upon the vantage ground of truth," nor with René Descartes that "To arrive at real truth is the only thing worth living for." Listen to Prof. Charles Richet:—"As Oliver Lodge has truly said, it is without the least enthusiasm that we come to the conclusion that these facts (the ordinary 'physical phenomena' of spiritualism) are true. It is even painful to declare the truth of these doubly absurd phenomena; absurd by the grossness and insignificance of the ridiculous manifestations; absurd because they are in contradiction to all known facts. . . . . From the experiments at Milan, Rome, and the Island of Ronband, we have only the scientific grief of bringing forward facts which confuse the intellect, which are absurd, and which no theory, however audacious, can pretend to account for, even in the smallest degree. Nethertheless they are facts; we have observed them well, and our duty was to disclose them."

Fortunately, there are other men of science who are more in harmony with truth.

Desmond G. FitzGerald.

Multiple Current Dynamos.

I observe that Alf. E. Wiever in his articles on "Practical Notes on Dynamo Calculations,"* ascribes to Mr. W. B. Sayers the device or invention of the method of obtaining two or more currents of different voltages from the same common armature and commutator of an ordinary continuous current machine. This method consisting in cutting deep wide slots parallel to the armature, producing neutral points upon which intermediate brushes may be placed.

This method was patented by me for the same purpose in Patent No. 1,640, April 4th, 1882. At that date an eminent professor went out of his way to ridicule the design before the Society of Arts in a Cantor Lecture, and afterwards referred to it in his books on dynamos as an example of a bad design, since then, however, the invention has again been discovered more than once, and now it is considered a most valuable method.

I hope to contribute an article on the construction and theory of this class of dynamo at an early date.

Meanwhile, I maintain my claim as the originator of this invention, which, like many another one was long before its time.

Rankin Kennedy.

Welsbach Light.

In the article on the Welsbach light, in your issue of January 5th, 1895, p. 59, you refer to some tests made by Heim. The reference is, *Lumière Electrique*, Vol. xxvi., 219.

This would be a very ancient volume. If there should be a misprint it might be worth while to call attention to it.

H. Borns.

[The reference quoted was taken from the treatise on "Photometry," by Dr. A. Palaz, Sc.D., published by Sampson, Low, London, 1894, pages 253 and 255. The date may be wrong, but the results, which are the important points, on Heim's tests are correct.—Eds. Elec. Rev.]

* *Electrical World*, New York.

Deakin & Spence's Lamp Pillar.

I am now able to give an exact statement of the facts bearing on the claim of Messrs. George Smith & Co., that they patented in 1892 a lamp standard in most respects identical with the arrangement described in your issue of March 29th.

On April 29th, 1892, Mr. J. B. Millar filed a provisional specification for "Improvements in and relating to posts or standards for carrying electric lights, wires, and the like," which as I have previously stated was allowed to lapse. The following day, April 30th, 1892, I filed a provisional specification for "Improvements in arc light poles or masts," which in due course was completed and issued as a patent.

A further improvement was provisionally protected by me on June 2nd, 1892, and this also was duly issued as a patent.

Finally (as I believe), Mr. Millar filed another provisional specification on March 2nd, 1893, for "Improvements in and relating to stepped pillars or standards for carrying electric lights, wires, and the like," which he again failed to complete.

Thus it will be seen that Messrs. George Smith & Co. *did not patent* a lamp standard in 1892, they got no further than the provisional stage, and, as a consequence, they are, just to the extent that their ladder "is in most respects identical" with ours, on the same footing as other infringers. Further, unless they have *some other real patent* to justify the use of the word "patent" or "patented" they render themselves liable, upon summary conviction, to a fine of £5 for every such offence.

Your editorial remarks in the Electrical Review of April 12th, about the combined ladder and switch gear, are, of course, in accordance with the facts—this arrangement was described and claimed in our first patent.

Wilfred L. Spence.

Quantitative Electrolytic Analysis.—No one is entitled to more attention on this subject than A. Classen, whose works are already regarded as classics. Hence we are glad to notice that he is laying special emphasis on a point to which we have repeatedly called attention when dealing with the subject, namely, upon the necessity for including the current-measuring instrument, be it ammeter or voltameter, in the electrolytic circuit, and upon the worthlessness of many published results, in obtaining which, a voltameter of unknown resistance has been substituted for the electrolytic cell at the moment of measuring. Classen's method is to couple in the main circuit, the battery, the electrolytic cell, an ammeter, a variable resistance, and a switch, by which the current may be stopped during the measurement of resistance. This latter is effected by means of a Wheatstone bridge, rheostat, and separate battery, which can be uncoupled when not in use. The voltage at the electrodes is determined by a voltameter, which may be switched on or off at will, and is placed in a shunt circuit between the anode and the cathode connections of the cell, using always the same electrode dimensions and interpolar spaces. Classen has made a number of observations which are detailed in a paper to be found in the *Berichte der Deutschen Chemischen Gesellschaft*, xxvii., p. 2,060, showing the temperature, current intensity, interpolar voltage, polarisation, added resistance, and electrolyte resistance at different periods of the work. In practice, one ammeter may be made to serve any number of electrolytic cells, and a special switchboard is described, which is so arranged that the current in any given cell may be passed through a separate ammeter circuit, or through a resistance equal to it, at pleasure; in this way a reading may be taken without any break of current or change of resistance. All the electrolysis cells are arranged parallel, but each has its own rheostat, capable of interposing a resistance of 60 ohms. Four secondary cells, with an aggregate interpolar E.M.F. of about 8·5 volts, are recommended for general use; they are more constant than primary batteries, and are preferable even in small laboratories. A separate circuit with special switchboards is arranged so that the voltage at the poles of any electrolysis cell may be at once determined, one voltameter being used for all. The paper concludes with a description of a long series of experiments. There is another paper on this subject in the *Zeitschrift für Angewandte Chemie*, 1894, p. 388, by F. Rüdorff.

THE USE OF ELECTRICITY FOR HEATING AND COOKING.

There are two names which instinctively are conjured up before our mental vision when the subject of cooking or heating by electricity is mentioned. One is Crompton and the other is Binswanger. On Wednesday last, Mr. Crompton was the means of ventilating this subject at the meeting of the Society of Arts, and the principal speaker in, and opener of the discussion, was Mr. Binswanger, who paid Mr. Crompton a well merited compliment for his paper, and at the same time gave some additional information on the subject. Without attempting to go fully into Mr. Crompton's facts and figures, it must be confessed that by far the most interesting feature of the paper was the statement that the recent advances which have been made in the development of electrical cooking devices have been due to the careful measurement which became possible when suitable means of thermometric examination were adopted. A great deal of the progress dates from the time when Messrs. Crompton and Co. began to make quantitative measurements, and thereby began to find out what they were doing. The most striking thing which was met with was the very small amount of heat which would suffice for culinary operations if made use of to the greatest advantage.

In Mr. Crompton's opinion, and no doubt many others will be found to agree with him, the re-invention by Callender of the platinum thermometer is one of the most remarkable occurrences of the last few years, as it enables us to learn so much about the thermal things of our daily life. Acknowledgment must be made to Callender, Griffiths and others for having brought the Siemens platinum thermometer into practical use; but in the form in which we are acquainted with it, it did not satisfy Mr. Crompton. He set to work to adapt it to the measurement of plate temperatures rather than to those of layers of air, and in lieu of the customary bridge arrangement, he uses the form of potentiometer with which his name is associated. The results which followed the application of scientific method were well told, and the figures given as to relative efficiencies of coal, gas, and electric cooking are not a little startling. The three points of cost, durability, and the application of electric heating to cases where high temperatures are required, as in the soldering iron, were threshed out by Mr. Crompton, Mr. Binswanger, and Mr. Dowsing in the discussion which followed the reading of the paper. Mr. Preece, who occupied the chair, told some amusing experiences of his own domestic life, and the effect that electric hot plates had upon the early rising of certain members of his family. Punctuality at breakfast, we gather, is now the rule, and yet this is the very opposite result from what one would at first imagine, but then, as the author of the paper said in referring to another matter, "it is clear enough if you think deeply about it, but most of us don't think deeply." A very appetising display was laid out on a side table, and Mrs. Seton, a true lady cook if ever we met one, did full justice to the capabilities of the electric appliances with which she was provided. With everything so charmingly neat and tidy, one can well believe that the ladies present would take kindly to electric culinary utensils, while the convincing arguments as to efficiency and cost would convert even those electrical engineers whom Mr. Binswanger blamed as being the worst offenders in exaggerating the expensiveness and drawbacks to the general use of electricity in the kitchen.

NOTES.

Coast Communication.—Mr. Robert Bayly, of Plymouth, in a letter to the *Western Morning News*, deals with several statements made by Captain Reading, the superintendent of the Western Trinity District, regarding the experiments and attempts to connect electrically, for communication, the lighthouses, lightships, and the mainland, which the Captain said had proved a failure. Mr. Bayly produces facts in refutation of Captain Reading's assertions.

Lectures.—On April 4th, Mr. Urban Bates, instructor of engineering at the Technical Schools, Banbury, gave a lecture in the Co-operative Assembly Rooms, Banbury, on "Electricity as applied to Lighting." The lecture was illustrated by means of experiments with the dynamo, &c., and a small installation of incandescent lamps, fitted with Ediswan appliances, was lighted by means of the dynamo, and then by a battery.

A popular lecture on the "Applications of Electricity" was delivered in the Electrical Engineering Lecture Theatre of the Croydon County Polytechnic, on Saturday evening last, the 20th inst., by Mr. H. Scholey. A short account of electrical units was first given to explain the meaning of the common electrical terms employed. Electric lighting, cooking, and heating were then considered from the practical standpoint, and apparatus for the purpose was shown. Lantern views were exhibited showing the interior of Hampstead electric lighting station, several interiors in which the electric light is used, with remarkably artistic effects, and some instances of electrical traction. The most novel demonstrations by Mr. Scholey were those of the Lagrange and Hope electric heating system, popularly known as the "water-pail forge," the electric furnace based on Moissan's model, and the production of acetylene by the action of water on calcium carbide. By the kindness of Messrs. Crompton & Co., Limited, The Lithanode and General Electric Company, Limited, The Crypto Works, Limited, The General Electric Company, Limited, and Messrs. Pyke, Harris & Co., Limited, who were good enough to lend apparatus, the lecture was amply illustrated by experiments, which were received with great appreciation by a large audience, including several well-known members of Croydon society. This is the last special lecture of the current session.

At Cheltenham, on Monday evening, a lecture on the "Electric Current and What it can Do," was delivered under the auspices of the Worshipful Company of Plumbers, by Mr. B. S. Gott, M.A.

One evening last week at the Andersonian Chemical Society, Glasgow, the closing address of the session was delivered by Prof. James Blyth, M.A., F.R.S.E., his subject being "Loose Electrical Contact."

Ferricyanide of Potassium as an Oxidant.—Experiments are being made with a view to utilise this oxidant in electro-chemistry. It is not at first sight obvious how this substance, which contains no oxygen, can act as a powerful oxidant; nor is the matter made quite clear when it is pointed out that free alkali must be present to render its oxidising power available. The explanation is that *ferricyanide* of potassium ($K_3\ Fe\ Cy_6$) has a great tendency to become *ferrocyanide* ($K_4\ Fe\ Cy_6$) by appropriating an additional atom of the alkaline metal contained in caustic potash (K H O). Doubling the residual H O, we at once see that 2 (H O) is equivalent to water and free oxygen ($H_2\ O + O$). The equation expressing the complete reaction is:

$$K_8\ Fe_2\ Cy_{12} + 2\ K\ H\ O = K_8\ Fe_2\ Cy_{12} + H_2\ O + O.$$

This reaction can readily be reversed by electrolysis.

Armature Reactions.—*Apropos* of a paper in the *Electrical World* for March 30th last, by Prof. Ryan, on "A Method of Preventing Armature Reactions," it seems very astonishing to find how people persist in disregarding the fact on which Mr. Sayers has laid so much stress, *i.e.*, that his device is not designed to prevent sparking simply, as he recognises the undoubted fact that machines are built which run absolutely sparklessly without it. The advantages secured by his device are that by its aid machines can be designed with iron embedded conductors, minimum clearance, minimum exciting force, and minimum weights and cost, while at the same time securing absolute sparklessness. The sparking, or rather the reversal of the armature sections, is in fact independently under the designer's control.

The Accident on the Liverpool Overhead Railway.—In further reference to our note on this subject last week, we are glad to learn that the accident that happened to Mr. Jones is not of a serious nature. It was caused by a "short" on the switchboard, his face and hands being badly burnt, but his eyes are not injured, and it is expected that he will be about again very shortly.

Leicester Electric Lighting Station.—The Leicester Corporation's electric lighting station was formally opened by Mr. Alderman Lennard at 12.30 yesterday, in the presence of a large gathering, and immediately afterwards steam was turned on by Mrs. Lennard, and the huge alternators set running, but without generating current. At luncheon the toasts of the Corporation, the Gas Committee, success to the electric lighting undertaking, and the contractors, were proposed, the last-mentioned in a most racy and humorous speech by Mr. Raworth. Throughout the proceedings, which the heavy and continuous rain did not mar, the band of the electric lighting and gas department played an admirable selection of music. Sir Courtenay Boyle was present among many others. The Gas Committee, the Corporation, the contractors, and Mr. Colson, the Corporation engineer, all deserve what we hope will turn out a big success.

Electric Canalisations in Paris.—At the sitting of April 6th, 1895, the Paris Municipal Council granted the Parisian sectors permission to lay their mains along the streets of Paris. The Sector of the Champs-Elysées Company has been authorised to lay mains in the Avenue Ingres, the Left Bank Company, along the Quai d'Orsay, the Avenue des Gobelins, the Boulevard du Montparnasse, and the Parisian Compressed Air Company, in the following places:—Place du Louvre, Rue de la Banque, Rue Vivienne, Rue du Chemin-Vert, Rue de la Feuillade, Place de la République, Boulevard des Italiens, both sides, Rue Baltard and the Place Saint Eustache, Rue Coquillière, Rue Jean-Jacques Rousseau, Rue Paul-Lelong, Rue du Louvre, and the Rue de Rivoli, between the Rue de Marengo and the Boulevard de Sebastopol.

Mining Fuse Accident.—An alarming explosion occurred one day last week on the premises of Mr. A. W. Bennett, electrical engineer, East Parade, Leeds. It appears that a number of electric fuses for mining purposes, which were being packed, suddenly exploded, causing a report which was heard for a considerable distance, and seriously injuring a youth named Humphreys, who, it is feared, if he recovers, will lose his eyesight. Mr. Bennett was also slightly cut.

Prof. Daniell.—The inventor of the Daniell battery was also the inventor of a method of measuring, or rather of comparing currents, by causing them to traverse the spring of a Bréguet thermometer. A "hot strip ammeter" was in use, therefore, long before the invention of volts and ampères. The same philosopher was the first to observe that a voltaic arc may be "struck" by means of an electric spark due to a discharge of static electricity.

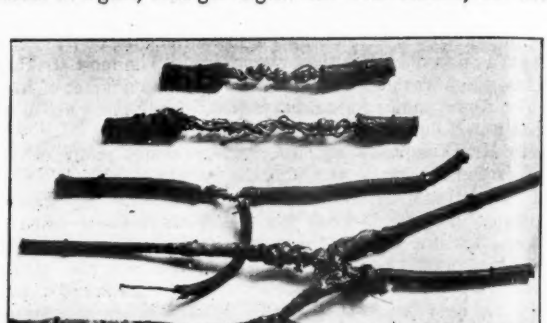
Inspection of Immigrants by Electric Light.—Passengers arriving at New York are now allowed to land at any hour of the day or night, the arrangement for this purpose being facilitated by the inspection of immigrants by the aid of powerful electric lights. A detached cluster of burners is so arranged, that it can be carried on board a steamer and connected with the electric lighting system of the steamship. To perfect this arrangement, all of that class of ocean-going passenger vessels known as express steamers will be fitted with a connecting arrangement, to permit the connection of the cluster of burners.

Bury's Late Electrical Engineer.—At the Spring Assizes at Liverpool, on Tuesday and Wednesday, an action was heard which had been taken by Mr. W. R. Wynne, the electrical engineer who was recently in the employ of the Bury Town Council, and to whose sudden dismissal we have already referred. The action was against the Town Clerk and the Borough Engineer for damages for having maliciously induced the Corporation to dismiss the plaintiff, for assault by the Town Clerk (Mr. Haslam), and for slander by the Borough Engineer. After over an hour's deliberation in private, the jury found a verdict for the defendants with respect to the alleged conspiracy to get the plaintiff discharged from the Corporation employment, also with regard to the slander; and for the plaintiff in the action for assault, awarding him 40s. damages. On the application of Counsel, his Lordship gave judgment for the defendants on the record as it stood.

Hard Solders for Brass.—There is an exceedingly useful paper on this subject in a recent issue of *Dingler's Polytechnisches Journal*, ccxciii., pp. 64—67 and 89—93. Whilst it is scarcely suitable for reproduction or even condensation in these pages, we think some of our readers may like to know where to find it: hence we give the reference.

Appointment.—Mr. Marcus S. Chambers, A.M.I.E.E., has been appointed by the Crown Agents for the Colonies resident engineer in connection with the Government electric lighting scheme at Malta, on the recommendation of Mr. W. H. Preece, C.B. Mr. Chambers proceeds to take up his appointment early in May.

Fires Made Easy.—We illustrate some joints which require very little comment; they have been cut from a private hotel in the provinces, which had its own plant—about 50 lights, with gas engine and accumulators, and two



arc lights. The two twisted strand conductors shown at the top of the illustration were on the arc light circuit, which, by the way, was joined up with the two lamps in parallel, instead of in series.

Defect in the Howth Telegraph Cable.—The Post Office steamship *Monarch* (Capt. Alford, R.N.), has overrun the Howth and Holyhead cable, in order to discover the position of the defect existing in it. It was found that the position affected was located about seven miles outside the Kish Bank. It has been cut out and a new piece spliced by the *Monarch*.

Correction.—In the article last week by Mr. A. F. Ravenshear, on the "Mechanical Equivalent of Light," a slight slip occurred in drawing the figure. The planes through H and L, cutting off from the solid, A B, the portion representing luminous energy should have been vertical instead of horizontal.

Fire.—The cause of a fire which occurred on Tuesday morning in a vault under the pavement at 173, Edgware Road, was, it is stated, to be fusion of electric wires.

Tests of the Niagara Dynamos.—A New York daily says that on April 5th the first test of one of the big 5,000 H.P. dynamos, recently placed in position in the power-house of the Niagara Falls Power Company, was made. A second trial was made on the morning of the 6th inst. before the officers of the Cataract Construction Company. Both tests are said to have been perfectly satisfactory.

The Royal Society.—The following papers were down for reading before this society yesterday afternoon:—"On a Gas showing the Spectrum of Helium, the reputed cause of D_3, one of the lines in the Coronal Spectrum," by Prof. Ramsay, F.R.S.; "Alternate Current Dynamo Electric Machines," by Dr. Hopkinson, F.R.S., and E. Wilson.

The Institution of Electrical Engineers.—At a students' meeting, to be held in the library, 28, Victoria Street, on Friday, May 3rd, 1895, at 8 p.m., the following paper will be read:—"Single-phase Alternate Current Motors," with illustrations, by A. C. Eborall.

BUSINESS NOTICES, &c.

Ready.—The Universal Electrical Directory. This directory for 1895, which is on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

Aberdeen.—The municipal buildings are now lighted by electricity, current being turned on on the 18th inst. There are about 200 lamps varying in power from 8 candles incandescent to 2,000 C.P. arc.

Aberystwyth.—A provincial paper says that the Council has decided to enter into a temporary arrangement with the Bourne and Grant Electrical Co. for the running of the electric light for the public lamps, pending the testing of the same, and the Council offer to pay for same at a rate not exceeding the rate provided by the existing agreement, but in the event of the light not answering the required test that the amount payable be in proportion to the candle-power as certified on behalf of the Council, viz, a rate of £20 per annum per lamp of 2,000 C.P. The arrangement is to be without prejudice to the rights or position of the Council, and to be terminated forthwith upon the result of the testing being communicated to the company. The committee further recommended that the lighting of the public streets by gas be discontinued where arc lamps exist.

Accrington.—A firm of electricians of Hapton, having informed the Corporation that they have been approached by several local gentlemen with a view to the formation of a company for the supply of electricity in Accrington, the Council has replied that it has already procured a site for a station and secured a £10,000 loan, and further "that the Council would not sanction any other applicational order."

Ayr.—The Commissioners' consulting engineer has recommended that if the council intend to light the Town Hall by electricity, the wires could be conveniently put in at the present moment. A committee has the matter under consideration.

Bath.—At the last meeting of the Surveying Committee the quarterly electric light bill presented amounted to £563 7s. 6d. From this a reduction of £20 is to be made on account of failures.

It seems that at last the Gas Company are to be rightly dealt with, at any rate in one respect, for doubts being expressed as to whether the gas quality comes up to the required standard, a committee has been appointed to inquire into the matter.

The City Council are meeting with some difficulty in respect of their application to the Board of Trade for a provisional electric lighting order.

Bournemouth.—At a recent meeting of the Vestry of the Holy Trinity parish the Vicar asked if General de Vitre could give them any information with regard to the cost of the electric light and the gas? General de Vitre cited two years by way of example with regard to gas. In the first of those two years the cost of the gas was £38 4s. 5d.; in the next £39 6s. 10d.; those amounts did not include the cost of repairs. The average cost of gas had been £38 15s. The electric lighting had been supplemented to some extent by gas; for example, during the first complete year in which they had the electric light, the gas used cost £2 16s. 3d.; and in the following year £4 1s. 10d. The electric light for that first year came to £34 17s. 6d., and adding the £2 16s. 3d., the total was £37 13s. 9d. In 1893-4 (which was the next year) the electric light bill was £26 4s. 3d., and adding the £4 1s. 10d., the total came to £30 6s. 1d. Last year the total for electric light and gas was £32 9s. 10d. The average cost per year for electric lighting, including also the gas used, was £35 10s. So that the electric light bills, even including the gas used, had been less than the bills for gas lighting.

Bristol.—Messrs. F. W. Ball & Co. have now completed the electric lighting of the Guildhall. Mr. Faraday Procter, the city engineer, reported on Friday last to the Finance Committee "that the work had been very well done."

Brixton.—The Brixton Independent Church authorities have determined to postpone the introduction of the electric light until mains are laid along the Brixton Road.

Buckden.—The Parish Council have come to the conclusion that electric lighting for their district is out of the question on account of the expense.

Cardiff.—"To encourage the use of electric light during the day" the Council is allowing a discount of 25 per cent. on large accounts in respect of lamps burning both day and night.

Cheltenham.—As at present arranged, the formal handing over of the Corporation electric lighting station by the contractors (Messrs. Siemens Bros. & Co.) will take place on Tuesday, the 30th inst.

Colombo.—We understand that a scheme has been submitted for lighting the fort electrically.

Dover.—The lighting of Buckland Church, to which we have already referred, is effected by means of 72 16-C.P. and 8 8-C.P. lamps. Messrs. Spagnoletti & Crookes carried out the wiring and fitting contract through their local agents (Messrs. Fletcher).

Folkestone.—The Corporation has accepted the invitation of the Dover Electric Lighting Company to inspect the station of that company.

Hammersmith.—The Vestry are at present treating for the purchase of land abutting upon Fulham Palace Road, for a site for a generating station.

Hampstead.—The London and Hampstead Battery Company, in referring to the proposal of the vestry to carry their electric lighting mains to Kilburn for the supply of the shops and streets of that portion of the parish, suggest that some scheme might be employed for the mutual advantage of the vestry and the company, the latter being of opinion that there was plenty of work for both to do. They stated that they would be willing to transfer to the vestry all the work which they held on the north side of Finchley Road, if the vestry would transfer to them that portion of their provisional order which covered the portion of the parish south of that road. The matter was referred to the Lighting Committee.

Hayfield.—The Parish Council are undecided whether to light up the village with gas or electricity, and a committee is investigating the matter.

Huddersfield.—The electric lighting accounts for the year show a deficiency on the revenue account of the works, of £2,065 4s. 9d. Mr. Calvert, at the last council meeting, stated that they were in a better position than last year, when there was a deficit of about £2,000 for only a part of a year's working. Had it not been for the heavy rate of interest to be paid on the loans, which covered a short period, there would be a profit on the works for the past year of £1,400.

Hull.—Yesterday a Local Government Inquiry was held into the application of the Corporation for sanction to borrow £2,800 for an extension of the electric lighting plant.

Jerusalem.—The Holy Sepulchre is about to be illuminated with the electric light.

Liverpool.—Sir Frederick Bramwell has been named as an expert to examine the figures—in the joint interests of the Liverpool Electric Supply Company, Limited, and the Corporation—upon which the Corporation has based its offer of £400,000 for the company's undertaking.

London, E.C.—At Tuesday's meeting of the Commissioners of Sewers a letter from the Comptroller was read, asking that Mr. Voysey, the electric light inspector, should be allowed to act as consulting electrical engineer to the corporation at a nominal sum. The consideration of this matter was adjourned until the next court.

Manchester.—The electric lighting of four out of the six new sheds at the Salford Docks has now been completed, and is in working order. The lighting of two of the sheds with 200 lights was carried out in a fortnight by Messrs. Bennett and Druce.

New Seaham.—The New Seaham Parish Council having considered the merits of gas and electricity, have decided to adopt gas. We do not know what influences weighed with the committee in coming to this decision.

Paris.—Messrs. Delaunay, Belleville & Cie, of Saint-Denis, have received an order to supply the boilers intended for the electricity works which the Compagnie Parisienne de l'Air Comprimé have just established at Quai Jemmapes. The installation will comprise three groups, each composed of four boilers of their C No. 8 type. The three groups are to produce altogether 36,000 kilos of steam per hour, to supply three engines capable of developing a total of 3,600 H.P.

Partick.—A committee of the local authority are considering the cost of providing electric light for the district.

Pemberton.—At a recent meeting of the District Council Messrs. Gaskell & Sharrock attended as a deputation with reference to their proposal to put down a small electric lighting plant for a portion of the West Ward.

Perth.—The local waterworks are to be lighted by electricity.

Wells.—The Council has consented to the application by Mr. A. D. Dixon Brown to the Board of Trade for a provisional order, authorising him to supply electricity within the area of the city, subject to an agreement lately submitted.

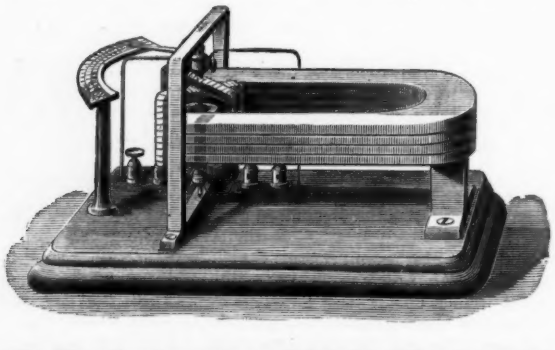
Wimbledon.—A local paper says that the offer of a consulting engineer (Mr. Preece) to report on the best means and cost of lighting the streets with electricity, for a fee of 50 guineas, has been accepted.

Woking.—There was a failure of the electric light in the chancel at Christ Church on Good Friday evening. A lamp had to be procured for the organist, and a choir boy held another while the lessons were read, but the choir had to manage as best they could.

Worcester.—At the Guildhall on 18th inst., an official inquiry was held as to the application of the council for sanction to borrow £20,230 for purposes of electric lighting. The Town Clerk explained that in August, 1893, the Local Government Board sanctioned the application of the City Council to borrow £39,109 for electric lighting purposes. That loan was intended to cover three items—purchase of land, £5,000; erection of generating station, £11,000; and generating plant and some mains in the city, £23,109. The City Council afterwards applied for a further £1,861, which was sanctioned in July, 1894. That referred to street lighting. As regarded the generating station, the council in the first place understood that the building would cost about £10,000, but the contract amounted to £14,797, leaving an excess over the loan applied for of £3,797.—The City Engineer explained that the plans had not been got out in detail when the estimate was given. The list of extra and additional works to the amount of £4,166 and other matters were explained in detail.

York.—The Electric Lighting Committee report that after considering the various tenders submitted for the electric lighting of the city, they have come to the conclusion that the scheme submitted by the Electric Construction Company, of Wolverhampton. is the most suitable for adoption by the Corporation, and they accordingly beg to recommend that this tender to supply the necessary plant and fittings for the sum of £10,865, be accepted. They also recommend the acceptance of the tender of the same company to work the plant for a term of three years in consideration of the payment to them by the Corporation of the following charges per unit for electricity supplied:—3¾d. per unit on a minimum of 75,000 units per annum, and on quantities up to 150,000; 3½d. per unit on 150,000 to 300,000 units per annum; 2¾d. on over 300,000 units. They further recommend that application be again made to the Local Government Board for sanction to borrow the sum of £15,000 for electric lighting purposes. With the report the committee submit a summary of the scheme proposed by the Electric Construction Company for the electric lighting of the city, and known as the Oxford system, and recommended for adoption.

A Combination Electrical Meter.—The meter shown in the illustration is adapted to measure and indicate with nicety the ohms, volts, ampères, or watts, in measuring an electric current. It has been patented, says the *Scientific American*, by Mr. Herschel C. Parker, of Brooklyn, N.Y. Supported on a suitable base is a permanent magnet, between the poles of which, on a common axis, turn coils wound respectively for high and low resistance, the coils as they turn moving a hand over a segmental graduation indicating ohms, volts, and ampères, and which may be marked to indicate



watts. The coils and magnets may, if desired, be differently arranged, but, as shown, the inner coil is wound for low resistance, and the outer one for high resistance, both coils being secured to upper and lower axles, on which are insulating collars with binding posts. Two of the binding posts are connected by light flexible wires with the low resistance coil, and by other wires with binding posts on the base, while two other binding posts on the axles are connected with the high resistance coil and with other binding posts on the base, the posts on the base being adapted for connection with the current wires to be measured. The coils turn against the tension of a light spring secured to the coils and to a bracket which supports a core centrally within the coils. The top axle carries the indicating hand, and the current may be brought to the coils, if desired, through the torsion spring. In use as an ohmmeter the high resistance coil is joined in parallel with the resistance to be measured, and the low resistance coil is joined in series, the action then being proportional to the ratio of the potential difference to the current, or from Ohm's law, $R = E \div C$. By giving the coils the proper resistance the deflection will be proportional to the ohms in the circuit, the ohms being indicated by the indicator hand on the segmental graduation. For use as an ammeter, the low resistance coil is employed, and for a voltmeter the high resistance coil, and the coils are arranged parallel instead of at an angle to each other for use as a wattmeter.

Bankruptcy.—The creditors of H. J. Kelly, manufacturer of electric light fittings, met on Wednesday last at the London Bankruptcy Court. The debtor, who is described as of 58, Bread Street, E.C., and 43, King's Road, Kentish Town, returns his debts at £2,751, and has no assets whatever. He states that since the liquidation of Poole & White, Limited, who traded at the above addresses, he has continued the business as Receiver for certain debenture holders until last February, when possession was taken on behalf of other debenture holders having a prior claim. The indebtedness related entirely to the business and was contracted in his capacity of Receiver. There was some discussion as to whether other persons could not be held liable for the debts, but no resolution was passed and the case was left in the hands of the Official Receiver to be wound up in the ordinary course of bankruptcy.

Book Received.—"Indicator Diagrams, and Engine and Boiler Testing," by Charles Day, Wh Sc. Published by the Technical Publishing Company, Limited, Manchester.

Business Announcements.—Mr. H. Jones has severed his connection with the firm of Messrs. R. W. Wilkinson & Co., and has joined the firm of Messrs. A. G. Beaver & Co., who won the chief prize last year at the Blacksmith Exhibition, which carried with it the freedom of the City of London and also the freedom of the Blacksmith Company.

Catalogues.—A revised list of electro-medical instruments has been issued by Messrs. A. Hurst & Co., of Fenchurch Street, E.C., who, we understand, always keep a stock of such apparatus ready for inspection. The pamphlet shows, perhaps, as good a collection of electrical apparatus used for therapeutic purposes as any we have lately had before us. Each apparatus dealt with is stated to have been expressly designed for its specific purpose. The following are a few of the articles of which details are given: galvanic, portable, and thermo-electric batteries, accumulators, induction coils, sledge coils for physiological purposes, instruments for electrolysis, controlling and measuring instruments, stationary batteries, cabinets for hydro-electric treatment, electric illuminating apparatus, requisites for galvano cautery, also a variety of other general and accessorial apparatus. The catalogue is neatly set out and altogether nicely got up.

The Electrical Engineering Company, of Minneapolis, has sent us one of their No. 3 catalogues of electrical supplies and apparatus. There is a great amount of information usual in such catalogues, describing, illustrating, and pricing a host of small electrical articles.

From Mr. Howard B. Little we have received price lists of medical coils and portable bell sets. We understand he has been reducing his prices lately.

D. & G. Graham.—This firm, whose address is 140, Douglas Street, Glasgow, have been compelled to apply for sequestration of their estates. The books have been placed in the hands of Mr. John M. MacLeod, C.A., 101, St. Vincent Street, Glasgow, who is preparing a statement of affairs.

Electric Candle Fittings.—Mr. G. S. Sluce, writing on this subject says:—"I have noticed in the last few issues of your paper that various persons claim to be the inventor of the new rubber-ended electric candle fittings, and to save further controversy in the matter, and also to warn intending purchasers, I beg to state that the use of rubber or any flexible material to provide a method of attachment, is claimed by me, as set forth in my patent, No. 10,597, May 30th, 1893. I may mention that the fittings can only be obtained through me, and that I have instructed my solicitor to proceed against those infringing my rights."

Ford-Lloyd Manufacturing Company.—The creditors and shareholders of this company met at Carey Street, W.C., last Wednesday to decide as to the appointment of a liquidator. Mr. G. S. Barnes, official receiver, reported that the company was formed in June, 1893, with a nominal capital of £10,000, to purchase and take over as a going concern, the business of electrical engineers and manufacturers of electrical apparatus carried on by the Ford-Lloyd Manufacturing Company, together with the sole right to sell and dispose of the invention known as the E.S. dry battery. In February last the directors passed a resolution for voluntary liquidation, but in the following month a compulsory winding up order was made by the Court. Debentures have been issued, and a receiver on their behalf is now in possession of the company's property. Accounts had been filed showing unsecured debts, £977; liabilities on bills discounted, £927; loans on debenture bonds, £3,000; and preference claims, £120. The assets were valued at £1,631, and were more than covered by the debentures, so that there was no prospect of any dividend being paid to the unsecured creditors. The company's failure is ascribed to lack of sufficient capital to work the business. No liquidator was nominated, and the official receiver will accordingly wind up the company in the usual manner.

[*Continued on page* 513.]

NEW METHODS IN CENTRAL STATIONS.

BELFAST AND LEICESTER.

The two electricity supply works which we are about to describe provide examples of the most recent practice in electrical engineering.

Compared with one another, the two systems under review are, of course, as divergent as two systems could well be; but they represent most vividly the extreme positions which the two great schools of electricity supply have now reached.

While the most recent designs of electricity works have exhibited a tendency to break away from methods which were becoming old-fashioned, not to say barbaric, it must be said that, as a rule, the designers have shown little desire to advance the science of the generation and distribution of electricity.

When we consider the lines on which many works have been laid down, some of which are models of what to avoid, we are driven to the conclusion that the "consulting engineer"—to use an euphemistic term—has rather hindered than helped towards arriving at an ideal system.

It is but just, however, to exclude from this reproach three or four engineers whose work has been done on the soundest principles. Central stations have suffered from the ignorance and the self-interest of designers. The results of blunders in such work however are not immediate. It is not until extensions become necessary that the errors in the design become apparent. The ignorant designer, in an endeavour to hide his ignorance, copies some other system; the self-interested engineer does the same thing because it saves him trouble. It was once said by a writer in this journal that a few years would see most of our central stations on the scrap heap. Though this gentleman may have been of a slightly imaginative turn of mind, there are certain electricity works which might be easily dispensed with at the present moment.

It may be said that we are taking a too pessimistic view of the matter, and that mistakes were inevitable when putting a new science into practical application. While fully recognising the weight of this argument, however, we feel constrained to say that most of the errors which have been committed in the design of generating stations have been due to the fact that the work has fallen into the wrong hands.

It might seem curious that we should be led to make the foregoing remarks when about to dwell upon the latest instances of central station practice; lest we should be misunderstood, we would say at the outset that it is the care exhibited in the design both of Belfast and Leicester which has led us to indulge in the foregoing lamentations.

BELFAST.

Turning now to consider Belfast more in detail, it is scarcely necessary to remind our readers that the most novel feature in the works is the adoption of gas engines for driving the dynamos. It is not only remarkable for this, it is noteworthy because it is probably the largest installation of gas engines in the world.

The Corporation of Belfast, acting, no doubt, under the advice of Prof. Kennedy, have confined themselves to supplying the central portion of the town. The city of Belfast covers a very wide area, and it might have been thought that a high pressure system would have been more suitable to the needs of the inhabitants, or at any rate would have been able to meet economically the future demand that may arise. We should, however, be doing Prof. Kennedy an injustice if we did not give him credit for having carefully considered all the local conditions, and selecting for the first operations an area that would be likely to give an almost immediate return on the invested capital. Consequently what may be termed the central area of the town has been selected, and plant has been erected on a suitable site, which is capable of supplying energy for some 8,000 8-C.P. lamps.

Briefly, the system is one of generation at 200 volts, and distribution on a three-wire method. In conjunction is a set of accumulators for use during the day, and at other times when the necessity arises.

The works are situate between Chapel Lane and Marquis Street, if that fact conveys anything to our readers. Speaking as almost strangers to Belfast, it seems to us that the site is almost, if not quite, in the centre of the town.

Viewed from the exterior, the building presents an unusual appearance when compared with the works using steam plant. The tall chimney does not exist, and the building is different in shape, being long and rather narrow, due no doubt to the absence of boilers. The interior is distinctly impressive, the gas engines being a good deal larger than one would be led to expect from the illustrations.

Before making any comments on the system, it would be as well to give a short account of the plant. Taking first the gas engines, which, by the way, are made by Messrs. Dick Kerr & Co., Kilmarnock, there are four tandem cylinder double acting gas engines, and two single cylinder double acting gas engines. The former are required to drive four 60-kw. dynamos, and the latter two 26·5-kw. dynamos.

The following details have been supplied by the makers:—The engines were made under Hartley & Kerr's patents, and are in some respects similar to the ordinary double acting engines which have been on the market for the last eight or nine years. The chief interest lies in the tandem engines which have been specially designed and built for this station; the two cylinders are in line, and the pistons are secured to the same piston rod, which works through a crosshead and connecting rod on to a single crank in the manner common to steam engines. The makers claim that this arrangement is simpler and more economical than the coupling side by side of two ordinary gas engines; the working parts are fewer and more easily got at, while the floor space required is only the width of an ordinary engine. The length of the tandem engine is no detriment, as the dynamo is placed near to the back cylinder, and driven by ropes running along the back of the engine.

The turning of these engines is very regular, owing to the fact of there being one impulse for every half revolution of the crank when running at full power, or four times as many as could be obtained from a single cylinder single acting Otto gas engine, so that these engines running at 160 revolutions per minute received 320 impulses per minute, the same as in a double acting steam engine. It is just as desirable that the engines should run steadily at light loads as well as at full load, therefore the makers have designed a special governor, by means of which the power of the impulses is diminished to a fixed point (similar in effect to the automatic expansion gear on a steam engine), after which, cutting out of the charges takes place, first at one end of one cylinder, then the other, and so on until all four working ends are running idle.

The consumption of gas is stated to be very low. Messrs. Dick Kerr & Co. inform us that at an official trial of a tandem engine at the makers' works, extending over six hours, at full load, it was found that the gas used per electrical H.P. did not quite reach 24 cubic feet, and the mechanical efficiency of engine and dynamo combined, 76 per cent. The output was 84 electrical H.P., being about 10 per cent. above the contract load of 77 E.H.P. (240 ampères at 240 volts). During the trial a main fuse "blew;" but so well was the engine governed, that, with the whole load suddenly thrown off, there was only a slight increase of speed and no sign whatever of racing. The engines run inwards, so that the slack of the driving ropes is on the top side. The method of starting these engines is interesting, and we shall refer to it shortly. The gas is practically delivered from the street mains straight into the cylinders of the engines, though on its way it passes through the meters. The main gas pipe is arranged on similar lines to steam pipes, it being connected to the engines by means of tee pipes. The water for the piston chambers of the gas engines is obtained from a tank, the circulation of the water being maintained by a small centrifugal pump under each engine. The gas for the ignition tubes is taken through a special pipe, and is measured by a special meter. Before speaking of the starting method, however, it will be more convenient just to refer to the electrical generating machines, which have been supplied by Messrs. Siemens Bros., Limited.

The Electric Generating Machinery.

The construction of the smaller dynamos embrace two or three novel and interesting points. In the four large dynamos, however, there is nothing special or peculiar; they are of Siemens two-pole drum armature type, size H.B. 15/23, the armature is wound with bars, the field-magnets

being in shunt. The output of each machine is 57½ kilowatts at 600 revolutions per minute. These dynamos have three bearings, and are driven by eight ropes ⅞th inch in diameter. The normal current is 240 ampères at any E.M.F. from 225 volts to 240 volts; but, exceptionally, an output of 210 ampères at 250 volts can be obtained.

The smaller machines, two in number, are specially adapted to fulfil three purposes, viz., to charge the accumulators, to act as balancing machines on either side of the three-wire system, or as motors to start the gas engines.

They are also shunt-wound two-pole machines, with bar armatures H.B. 12/16, but the armature of each dynamo is provided with a double winding and with two commutators. The brushes of each commutator are connected to four terminal blocks for each dynamo, so that the two windings can be put either in series or in parallel, while, as in the case of the four large dynamos, the strength of the field can be varied by putting extra resistance in or out of circuit. The speed is always 750 revolutions per minute, and the load is 26½ kw. This output admits of the following variations:—

A. Two windings in series—

Normal output ...	110 ampères at	240 volts.
Exceptional „ ...	80 „	270 „

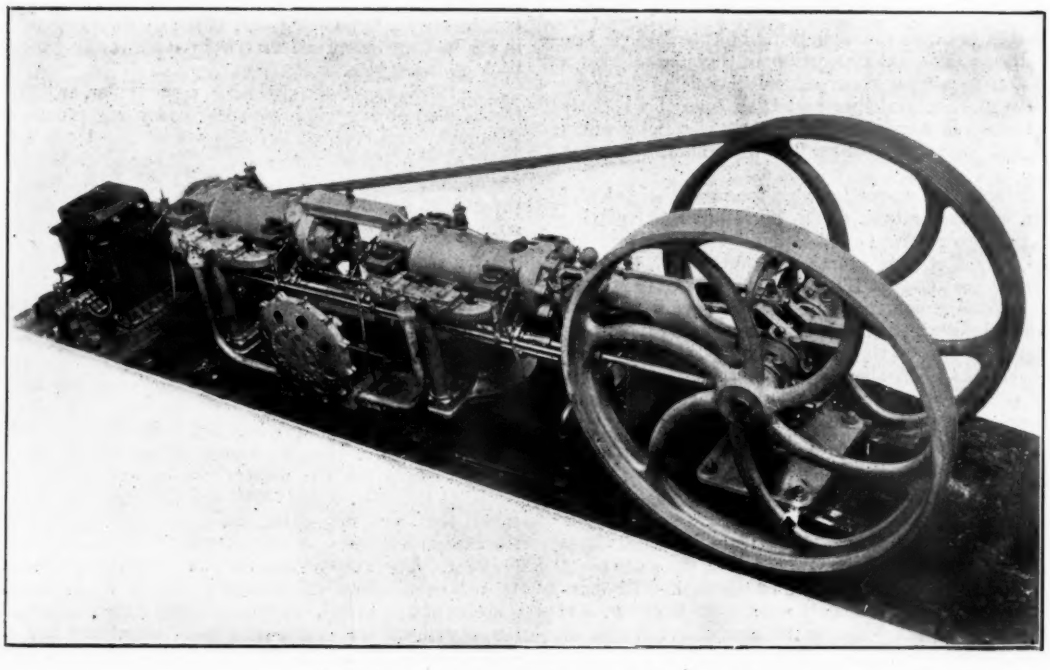
B. Two windings in parallel—

Normal output ... 200 ampères at 110 to 120 volts.

are arranged. The switchboard is divided into panels, one side of the switchboard being negative and the other side positive.

The most novel features of the switchboard is the battery regulating device, which places the middle batteries in parallel, as opposed to the old arrangement of putting in more or less cells, the battery being regulated from the centre panel of the switchboard. The second feature is the automatic cut-out, which cuts out the dynamos from the battery circuit when they have been run as motors to start the gas engine. Without drawings, however, it is difficult to make this quite clear, and though Prof. Kennedy has been good enough to lend us diagrammatic drawings of the switchboard, the great pressure on our space compels us to leave them over. The switchboard has been made by Messrs. J. H. Holmes & Co.

In the distributing system, a good deal of care and skill has been necessary to overcome the obstacles imposed by the peculiar conditions of the soil. For the most part a bare copper system has been adopted, though under the roadways Callender's cable is used as well as in some of the narrow streets. A concrete trench is employed, in which the bare copper mains are laid. Owing to the extremely wet nature of the soil, a most careful system of inspection has been organised; the box covers are provided with inspection plugs, which, when taken out, allow the men, who are sent round every morning, to pass in a pole, and thereby ascertain the height of the water.



View of Gas Engine Coupled to Dynamo.

It is to be remembered that, in accordance with the specification, all the regulation of E.M.F. is effected by variation of the strength of field, the gas engines running always at the same speed.

The gas engines, as we have already stated, are started electrically, that is a current from the batteries is sent into the field magnets of the dynamos and they become, in effect, motors running the reverse way. The automatic switch, which has been devised by Prof. Kennedy, cuts the machines out at the necessary moment. We had the pleasure of witnessing the starting up of one of the small engines, and though three or four of the drivers helped to give the initial start the help was comparatively small, and the method of starting must be considered successful. It is, however, not an easy matter to start the engines, and the power they require is considerable, it being, in the case of the small engines, as much as 35 horse-power.

The secondary batteries are divided into two sets, each containing sixty-three cells of the 34 K. E P.S. type. We give an illustration of the room in which the accumulators

Comments.

The adoption of gas engines at Belfast has created a genuine interest, and the results of working will be important. To speak frankly, however, we do not think the use of gas engines will be advanced very much by the Belfast system. It may be that the gas engines will not have a fair trial; but it is quite certain that the cost of working will come out very high. If the Corporation Gas Committee insist on charging for the gas on the same basis as that charged to ordinary consumers, which is about 2s. 3d. per 1,000 cubic feet, then we may reasonably expect the cost of fuel to amount to something like 1·6d. per unit sold. Supposing, however, the Corporation make large reductions, then, of course, the cost of fuel may be materially cheapened, but there would be a strong argument against the adoption of gas engines by the Corporation where it was necessary to obtain gas from a private company. We do not quite know whether the cost of labour will tell against the system, certainly more drivers would be required in a station like Belfast

than would be needed in a Willans station of the same output, though, of course, the saving in stokers may to some extent compensate for this. To our mind, an objectionable feature is the extreme noisiness of the plant, and there may be considerable vibration communicated to adjoining walls. We believe, however, that all the objections we have set forth will be properly met in newer plants; certainly they will need to be before we can really advocate the abandonment of steam engines in favour of gas.

The station is small, as corporation works go; perhaps the experimental nature of the system rendered it unwise to make it much larger. There are probably 6,000 8-C.P. lamps connected at the moment, though 10,000 is about the capacity of the station.

Mr. Victor McCowen is the resident engineer.

THE LEICESTER CORPORATION WORKS.

It is admitted on all hands that the electric lighting works which have been just laid down by the Corporation of Leicester are among the handsomest in the country. We have often protested with no uncertain voice against the inartistic ideals held by the usual run of central station designers. No doubt the question of cost is an important factor in electric lighting works, and to follow out any plan of elegance must cost money. On the other hand, central stations are expected to last a good many years, and a slightly increased cost at the outset cannot be objected to on reasonable grounds.

The Leicester works in the interior arrangements are distinctly in advance of anything we have in this country. It is a departure from the usual practice in that the generating machines form a distinct part of the engines, similar in fact to what we may term the Portsmouth system; it constitutes also an important departure from English practice in that the objectionable steam pipes have been eliminated from the engine room and relegated to the regions below. We have often thought, and indeed said so, that English engineers might with some advantage follow Continental methods in this respect. It has been often admitted by English electrical men that Cologne, for instance, provided perhaps the finest example of a central station, yet no one has had the courage or the opportunity to imitate. On the Leicester works Cologne has undoubtedly left its impress; indeed, Mr. Colson, the gas engineer of Leicester, makes no secret of the fact that he has followed Continental designs, and so far as we are able to judge the result has amply justified the course he has taken. No doubt there are well-designed stations in this country, which, with an equal output to Leicester, have cost less; but if electrical works are intended to be permanent, and few of us would like to think otherwise, it is surely wise to make them as substantial and as elegant as possible, compatible, of course, with reasonable expenditure. It is not every municipality, however, that would be disposed to grant a slight increase for what electrical men consider embellishments, but the Leicester Electric Light Committee had before them the goodly example of the gas works, which are perhaps the finest in the country, and it was perhaps reasonable that they should desire their electrical works to be quite in keeping with them. They have attained this end, and though there may have been present at yesterday's ceremony engineers who, though looking with suspicion on the principles involved, could not help admitting the soundness of the work, both from an electrical and mechanical point of view.

Perhaps the most remarkable feature about the establishment of the Leicester works is that they have been designed and laid down by a gas engineer. Mr. Colson, who has been responsible in every way for the scheme, is, first of all, a gas engineer, and it certainly says something for the fitness of gas engineers to cope with the problems of generation and distribution of electric energy, if they deal with the subject in a similar manner to that evinced at Leicester.

Like most other large towns, the Corporation of Leicester were early in the field to secure a provisional order. One was obtained in 1890, but it was not until 1892 that the electric light committee, which had been formed in the meantime, advertised for tenders, plans, and specifications for the supply of electricity. Though certain lines and conditions were suggested to contractors, considerable latitude was allowed in the preparation of their schemes. Broadly, the invitation issued was for complete schemes and tenders, together with specifications and general drawings for the generation and distribution of current for a specified number of lamps assumed to be about evenly distributed throughout the "limited area"—that is, that portion of the Borough bounded by Belvoir Street, Welford Place, Pocklington's Walk, Berridge Street, Grey Friars, Loseby Lane, Cart's Lane, High Street, Eastgates, Haymarket, Gallowtree Gate, and Granby Street, an area of 36,300 square yards, and comprising the centre and best business part of the town. The site for the generating station, the system of supply, the method of distribution, and kindred matters were left to the discretion of the competitors. They were to provide in their schemes and tenders for such reserve plant and apparatus as they deemed necessary. In preparing their plans and estimates the competitors were to bear in mind that, although the Corporation would go to no needless expense, on the other hand their object would not be to obtain the cheapest installation irrespective of its merits. The endeavour would be primarily to secure such an installation as would comply with the following conditions:—

(*a*) Perfect safety, *i.e.*, so far as science could render it, free from danger to life and property.

(*b*) The generating station to be placed as to avoid every risk of nuisance or annoyance from vibration, &c.

(*c*) The system to be thoroughly elastic, *i.e.*, capable of easy extension without extravagant outlay.

(*d*) The method of distribution such as to necessitate as little interference as possible with the streets and roadways, not only when first laid down, but also in the case of renewals or deficient supply of current.

(*e*) Every portion of the scheme and apparatus in connection therewith to be well beyond the experimental stage, of thoroughly approved efficiency, and to be of the very best description, both as regards material and workmanship. The machinery to be of such design as to reduce the wear and tear and risk of breakdown to a minimum.

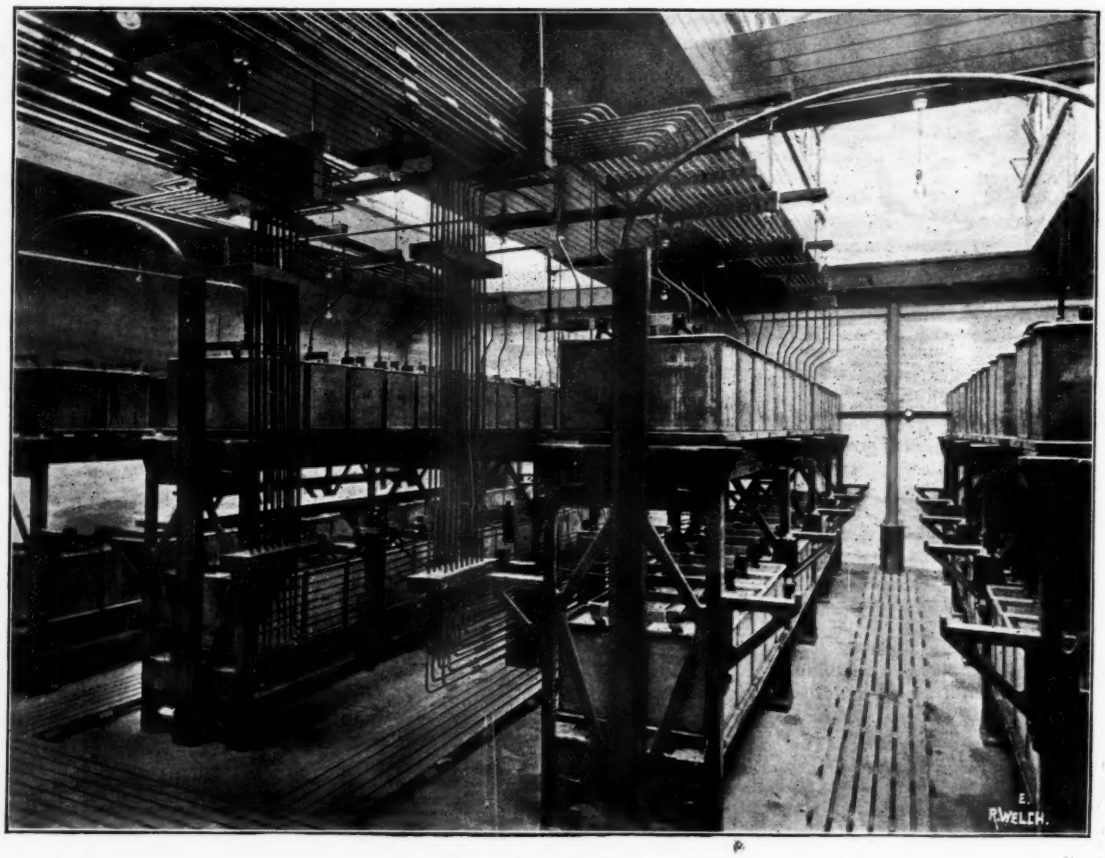
In reply to the advertisement, 17 competitors submitted 25 schemes and tenders, several offering alternative plans. In all there were six systems recommended as follows:—

Direct high tension, alternating current, with house transformers	4
Direct high tension, alternating current, with outside house transformers	1
High tension, alternating current, with street transformers and low tension distribution	15
High tension, continuous current, with street transformers and low tension distribution, assisted by accumulators	2
Low tension, with accumulators	2
Low tension, three-wire system, with accumulators ...	1

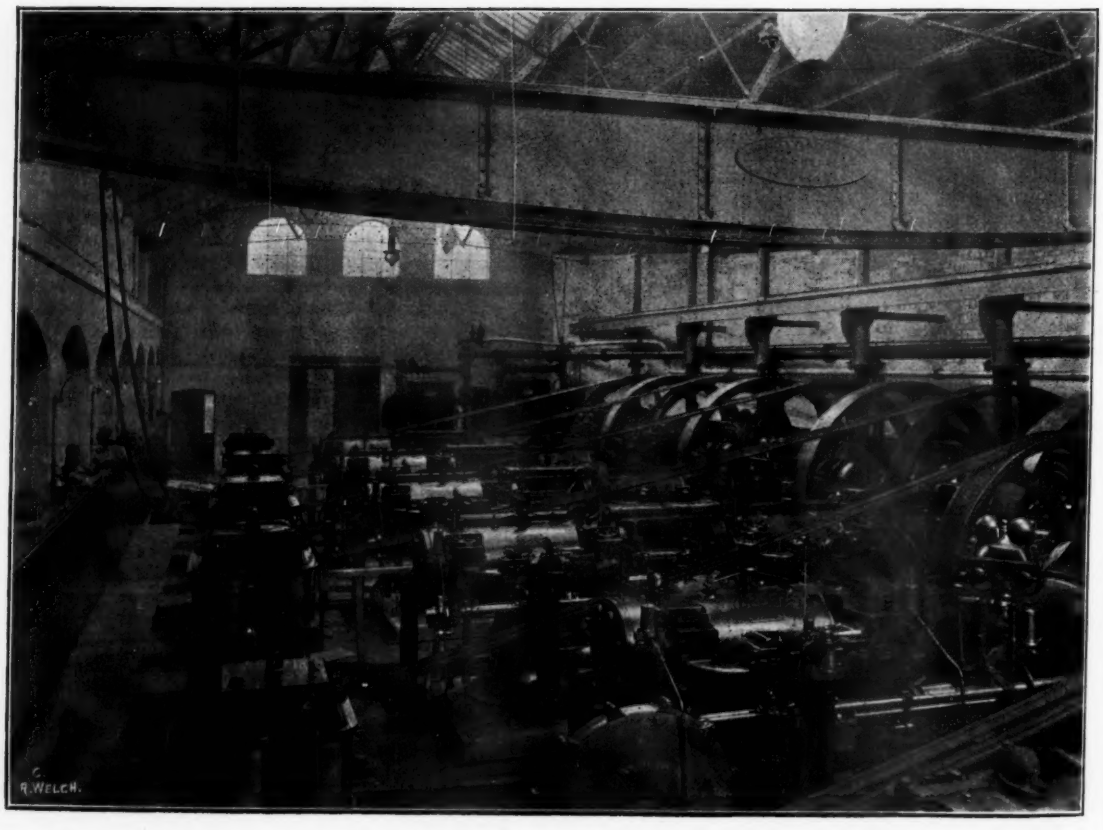
As to site, 14 competitors recommended the Aylestone Road Gas Works, and three were in favour of the works being placed in the town, within the limited area.

In January, 1893, the engineer submitted his report upon the schemes and tenders, and in the following month that of the Brush Electrical Engineering Company, with certain modifications suggested by the engineer, was, upon the recommendation of the gas committee, accepted by the Town Council. The contract entered into was for the supply of the whole of the electrical plant and boilers. The order for the engines was ultimately placed with Messrs. Hick, Hargreaves & Co., of Bolton. In August of the same year the usual Government inquiry was held, and in the following month sanction was obtained for the expenditure of £42,574 in connection with the work. This amount is estimated to cover not only the cost of the present installation, but also a further extension of cables. The system adopted was the high tension alternating current, with street transformers, and low tension distribution.

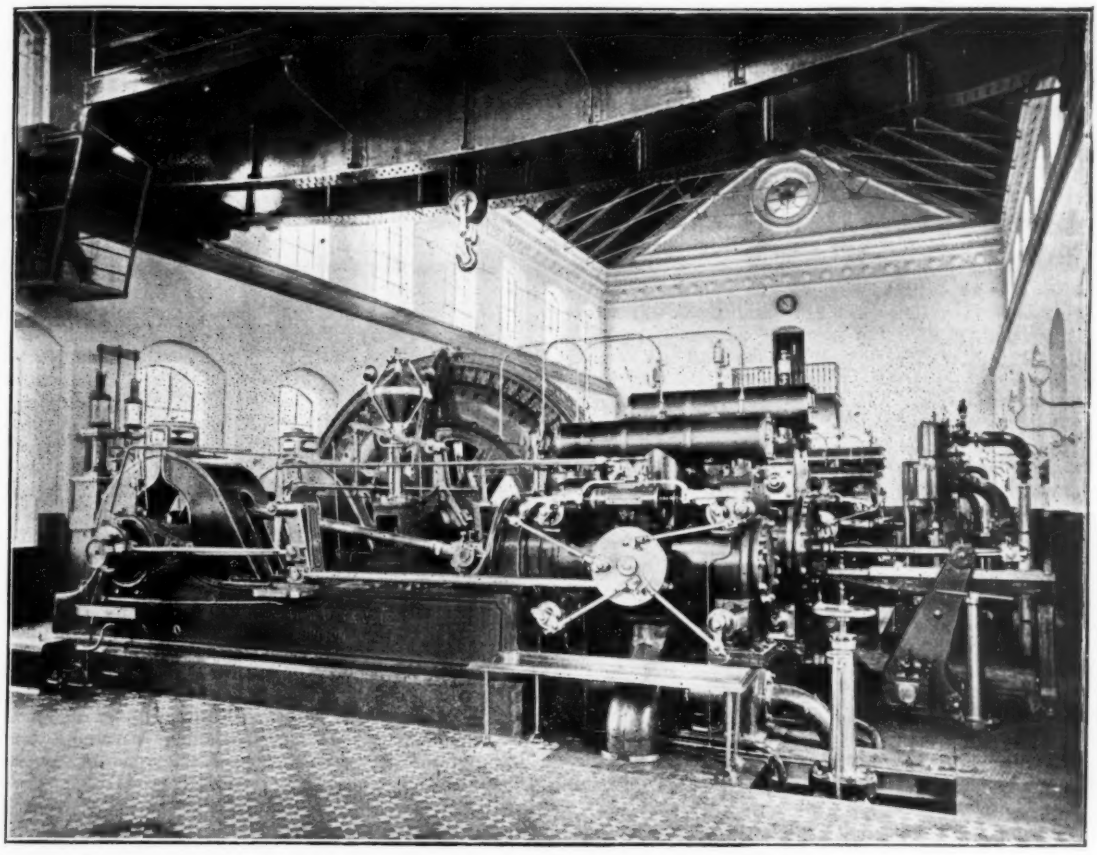
The central station is situated about 1½ mile from the centre of the town, at the gas works on the Aylestone Road. It stands on the left-hand side of the main avenue running through the works. The station has been built from designs by the engineer, and with his own men, no contractors having been employed. It is a red brick structure, corresponding in its general features with the buildings of the gas works, and comprises vestibule, engine and dynamo room, boiler house, office and testing room. The vestibule is 18 feet by 13 feet, with a mosaic floor and tiled dado. It



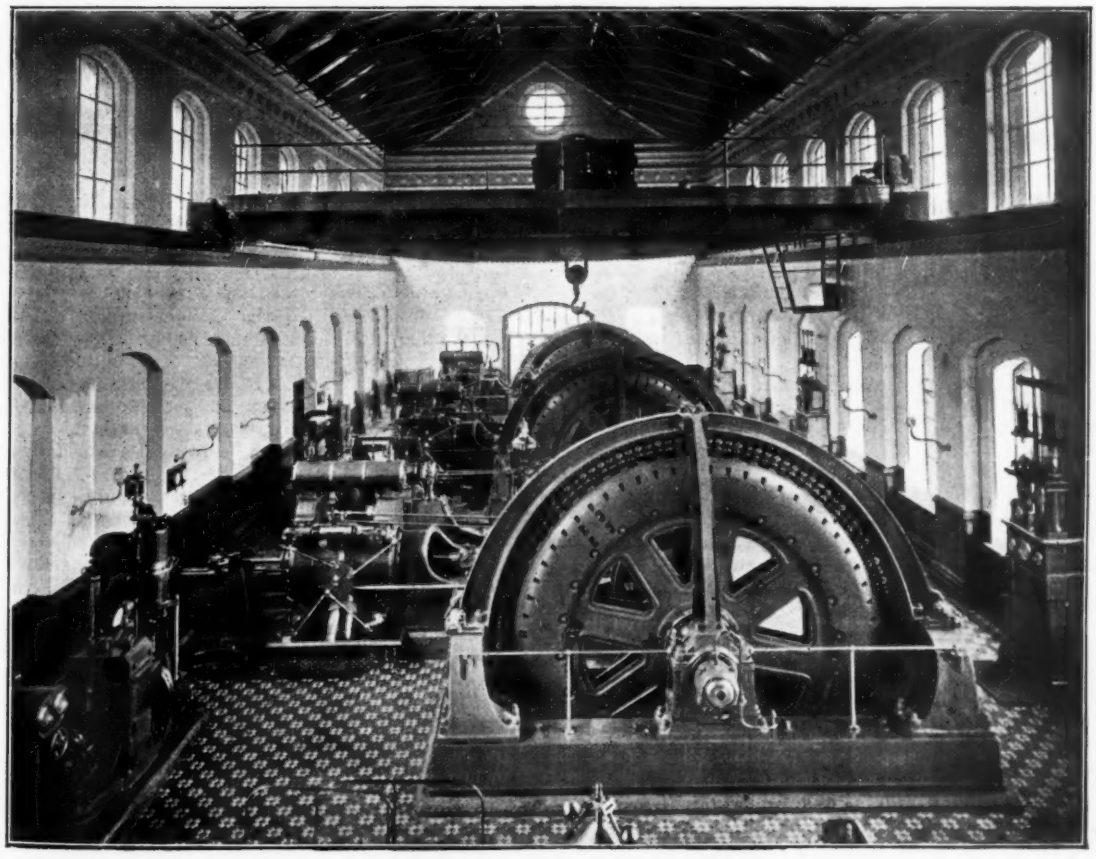
Belfast.—Accumulator Room.



Belfast.—Engines and Dynamos



Leicester.—View of Engine and Alternator.



Leicester.—General View of Interior.

is entered by half-glass folding doors, with a similar pair leading therefrom into the engine and dynamo room. This, the main feature of the building, is 114 feet long, 40 feet wide, and 31 feet 6 inches high, lighted with a double tier of windows on both sides, except where the boiler house abuts and one end. The roof is supported by wrought-iron principals, and formed of pitch pine rafters and purlins filled in with diagonal match-board panels. The floor is formed of rolled steel joists filled in with cement concrete, and paved with tesselated tiles. A dado encircles the room formed of match boarding, with moulded cap and skirting, the whole being stained and varnished to correspond with the roof. As we have already said, the appearance is very much enhanced by the absence of steam pipes. The room being cellared, enables the whole of the steam pipes, air pumps, steam receivers, traps, &c., to be kept out of sight, and also affords every facility for making the various electrical connections, &c. It also gives ready access to the lower portions of the armatures.

There are in all four pairs of engines of the horizontal compound condensing type, three of 300 brake H.P., and one smaller pair of 112 brake H.P. The larger engines have cylinders 16 inches and 30 inches in diameter × 3 feet stroke, and are coupled by means of a Raworth coupling direct to Mordey alternators, each of 200 kw. capacity, which they drive at a speed of 96 revolutions per minute. Both cylinders are fitted with Corliss valves and gear throughout, and are thoroughly steam jacketed. The cylinders are built up of separate castings, which consist of four pieces, namely, a liner, a casing, and two end valve chambers. The advantages of this system of construction are obvious, as it means the substitution of four simple castings, which can each be cast of a mixture most suited to the purpose, for a single casting of so complicated a nature that it can only be cast of a comparatively soft mixture, and is even then liable to fail from initial stress, aided by unequal expansion.

The steam traverses the jackets on its way to the cylinders. This method of jacketing is almost universal on the Continent, and is largely used in America, the lowest steam consumption ever recorded having been obtained, we understand, from engines jacketed on this principle. We understand that Messrs. Hick, Hargreaves & Co. adopted this system some time back after careful consideration, and they are more than satisfied with the results since obtained. Its advantages are that there is no possibility of any accumulation of air or water in the jackets, the volume of steam passing through them being so great, as to sweep away any accumulation of air or water directly it is formed. It also renders it impossible to heat the jackets without heating the cylinders, and the great strains due to unequal expansion and contraction are thus avoided. Also the efficiency of the jackets as a heating medium is greatly increased, owing to the comparatively high speed with which the steam passes over the surface to be heated.

There is a steam jacketed receiver between the H. and L.P. cylinders, in the jacket of which the full boiler pressure is always present.

The main frame of the engines is of the box form, and is made very deep in order to form efficient crank-race oil drippers. The cylinders are attached to the end of the bed plates by means of hood pieces, sometimes called target ends. The valve gear differs from that of Messrs. Hick, Hargreave's usual type, having been designed especially to meet the demands for dealing with great and rapid variations of load, peculiar to electric lighting. We believe this gear is now running in other central stations, and, so far, we understand that the results have fulfilled all expectations, the entire load being thrown on and off the engines repeatedly with a minimum variation in speed. The gear gives very good and rapid port openings, and a great range of cut-off from nothing up to $\frac{3}{4}$-inch stroke. The governor controls the cut-off in both H. and L.P. cylinders, which, according to latter-day notions, is essential when dealing with great variations in load. Most of the working parts of the engines are of steel, such as the piston rods, cross-heads, crank-shafts, valve gear, &c. The governor is of the high-speed pattern, modified Proell type, with a heavy centre weight on the spindle. Means are provided for altering the speed of the engines slightly for synchronising purposes, and there is a safety stop motion fitted to the governor, which stops the engine at once in case the belts driving the governor break, and the governor falls to the bottom, or if from any cause the engines should get so much overspeed that the governor rises to the top of its range. The crank-shaft is of the double throw type, made in two pieces, bolted together with solid flanged couplings forged on the shaft, the flanges of the coupling forming the seat on which the belt pulley driving the governor is fixed.

The air pump and condenser stand behind the low pressure cylinder, the latter being of the jet type. The air pump itself is of the vertical single-acting description, and is driven by means of wrought-iron lever links from the tail end of the low pressure cylinder piston rod prolonged for this purpose.

The above remarks also apply generally to the smaller engine, the only difference in design being that this engine has a slide valve to the low pressure cylinder in place of the Corliss gear. The cylinders of the smaller engine are 11 inches and 20 inches in diameter by 2 feet stroke, and are intended to give the 112 brake H.P. at 118 revolutions per minute, the boiler pressure for all the engines being 120 lbs. per square inch.

The alternators are of the well-known Mordey type, though the special conditions have necessitated some slight alteration in the form; they are, however, of the same general design as those in use at the Bankside Station of the City of London Electric Lighting Company; the armature is stationary, and the larger size carries 120 coils wound on slate formers and fixed in German silver and ebonite brackets; they are set radially round a gun-metal ring which is bolted to a cast-iron frame divided into four sections, two of which are below the floor level; each section is centred on end girders of cast-iron, and can be readily swung back for inspection or repair of the coils. An equaliser is placed in one of the end girders, as the two halves of the armature are connected in parallel. The field magnet consists of massive steel castings with 60 pairs of polar projections, and is excited by one central coil provided with two gun-metal collecting rings mounted on the shaft, and the whole rotates in ample swivel-bush bearings, through which a continuous circulation of oil is kept up by means of pumps worked off the shaft. Three of these alternators, as we have already said, have an output of 200 kilowatts each, and the fourth is a light load plant with an output of 75 kilowatts. The working pressure is 2,000 volts. The exciters consist of two Victoria continuous current dynamos each of 13 kilowatts capacity. The following switching pillars, all being Raworth's patent, are also provided—viz., four alternator pillars, two circuit pillars, one general purposes pillar, one dividing table, and two exciter pillars.

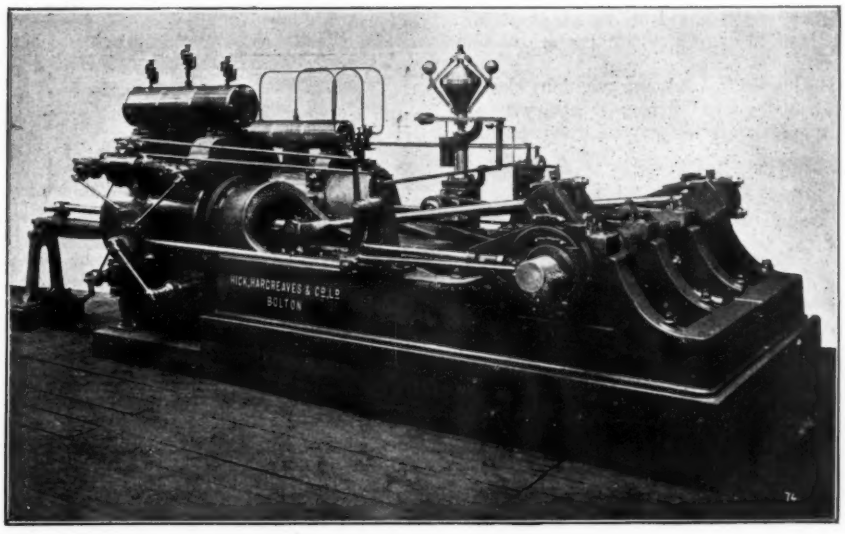
A special feature in connection with the switching arrangements is the employment of a dividing table and general purposes pillar. By means of the former, which is practically an "inner" omnibus bar, any section of this system can be isolated and locked off. The "outers" of the system are put direct to earth. As regards the general purposes pillar, this is an arrangement which by interlocking renders it impossible for the exciting circuit to be broken when changing exciters. It also prevents any mistake being made in connection with the electrical arrangements for the crane, which can be driven from either exciter.

The basement of the engine room is reached by an iron staircase fixed at either end of the room. A 15 ton overhead travelling crane traverses the length of the room. This can be worked either electrically or by hand. Electrically the two traversing motions and the lifting and lowering are obtained by the use of three Brush Vienna motors. The switches controlling these are fixed in a cage suspended under the crane. This arrangement allows of one man conducting the whole of the operations.

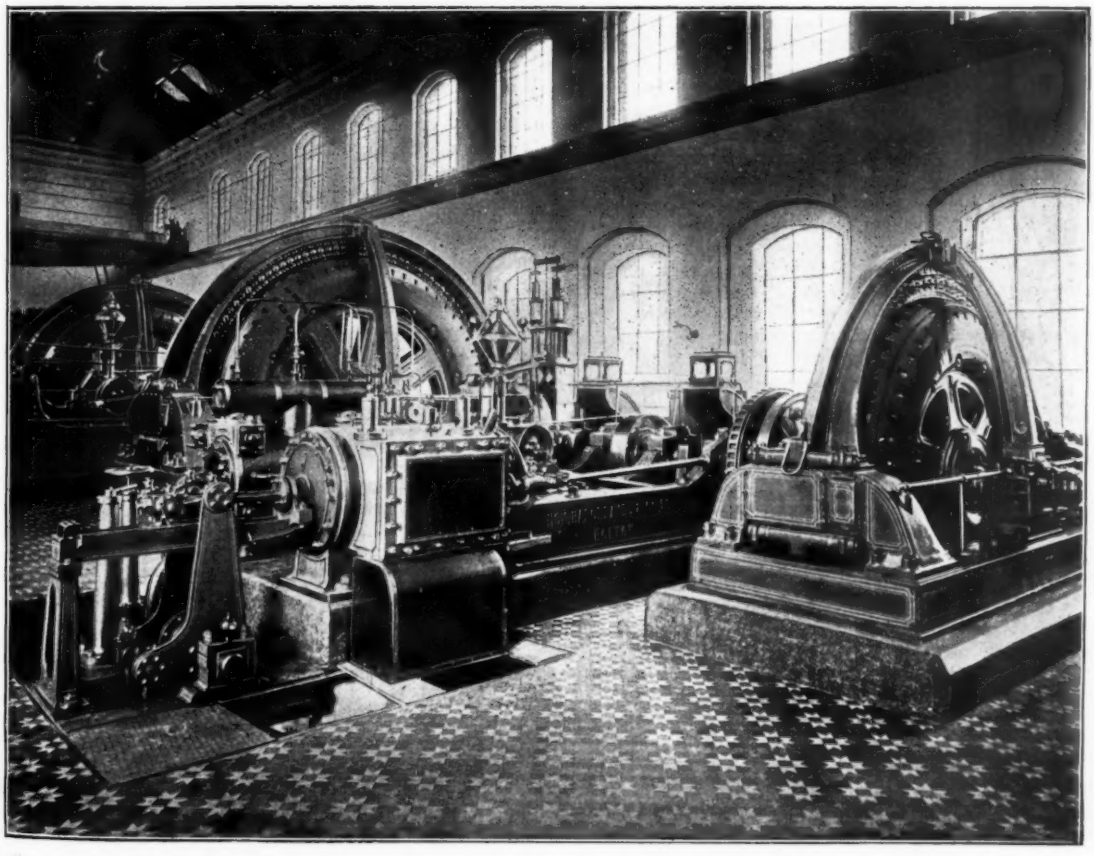
Adjoining the engine room is a workshop, measuring 26 feet by 18 feet. When finished, it will be fitted with a complete set of machine and other tools. Over the vestibule and shop is an office and testing room, reached by a spiral staircase, and measuring 41 feet by 18 feet, with a roof corresponding to that of the engine and dynamo room. Here will be fixed all the testing instruments and apparatus required in connection with the station. From this office access is gained to a balcony overlooking the whole of the machinery.

The boiler house stands at the rear of the main building, the back wall of which is common to the two. It measures

55 feet by 42 feet, and contains four Babcock & Wilcox tubular boilers, each of 250 N.H.P. These work at 120 lbs. pressure. Foundations are already in for two more boilers of like size. The feed water is supplied by two three-throw pumps, each with engine attached, through a Babcock and Wilcox economiser, placed in the main flue leading to the chimney. The fuel at present employed is coke from the gas works. In one corner of the boiler house is fixed an Evans's duplex pump for pumping water, for feed and other purposes, from the river into an overhead tank, placed in the adjoining chemical works. The water for condensing is taken direct from the river, the difference in levels fortunately allowing this to be done. The three openings into the boiler house are protected by revolving shutters. The draught is obtained from a stack, 125 feet high.



Leicester.—View of Engine.



Leicester.—View of Alternators.

On either side of the station are railway lines in direct communication with the sidings at the gas works. These afford great facilities for the delivery of plant and apparatus, as well as fuel for the boilers.

No little difficulty was experienced in connection with the

foundations for this work. This arose from the close proximity of the site to the River Soar and to the subsoil consisting of peat, running sand, or silt. To avoid the slightest risk of settlement in any part of the work, the whole of the foundations were carried down to a depth of 22 feet, viz, to the Keuper bed, which consists of good hard red marl. The foundations of the walls of the building are of blue lias lime concrete, while those for the engines and alternators are composed of Portland cement concrete and brickwork in cement. The beds for the whole of the machery are formed of best Derbyshire stone.

At present the station is lighted by gas, incandescent burners being largely used. It is hardly necessary to say that the electric light is also to be employed for this purpose.

Method of Distribution.

The whole of the cables, both high and low tension, are of Messrs. Fowler-Waring Co.'s manufacture, and are concentric in form. From the central station are two, lead covered and armoured, laid direct in the ground at a depth of 2 feet, run direct to No. 1 transformer chamber situated in Market Street. From this chamber the high tension mains are drawn in 3-inch cast-iron pipes, and form a ring encircling the limited area. By means of switches placed at two points in this ring, the circuit can be divided into two sections, for the convenience of testing and making alterations and connections.

The low tension mains are of one section throughout, viz., 1·46 sq. in., lead-covered and armoured, and laid direct in the ground at a depth of 2 feet. The house service connections, also concentric, are teed direct to these, a lead joint being wiped on to insure the lead covering remaining intact, the whole being armoured by a cast-iron tee clamp.

The transformer chambers are eight in number, their internal measurement being 7 feet 6 inches long, 5 feet 6 inches wide, and 7 feet high. The sides and ends are segmental, having a rise of 6 inches. The walls of the chambers are formed of good hard bricks in cement in two thicknesses, with an inch space between. This space is filled in with specially prepared asphalte, which is also continued under the paving of the floor as well as over the roof, thus making the chamber perfectly water and gas tight. The roof is formed of rolled steel joists filled in between with cement concrete. A suitable manhole with double cover is provided for access to the chambers, which are descended by means of step irons built into the inner thickness of wall. All the chambers have an air inlet and outlet for securing proper ventilation. The bell mouths of the pipes carrying the high tension mains are caulked with vulcan cement, with the object of preventing any gas finding its way into the chambers. As an additional precaution against this occurring the pipes are provided with a ½-inch hole about a foot from the back of the wall of the chamber, which communicates with a ventilating flue. This arrangement allows any gas which finds its way into the pipes escaping before reaching the chamber. A similar arrangement with the same object is provided in connection with the low tension cables.

The transformers in the chambers are connected to the high tension system through Bates fuses, D.P. high tension switch, and Geipel's patent joint box, and to the L.T. omnibus bars through a combined D.P. switch and fuse. The transformers, switches, joint boxes, and frames are all carefully earthed in order to minimise danger. The transformers are the usual Mordey type, all being fitted with earth shields.

The light was first supplied to the town on December 19th last. At present no cables are laid beyond the limited area, but recently the gas committee decided to carry these through Stoneygate, the residential quarter, for a distance of something like two miles. The total number of meters fixed is 91, and lamps wired equal to 6,000 8-C.P. The price at present charged is 6d. per unit. In connection with this work has been organised an electric light fitting department, the result of which has been that the greater portion of the wiring and fitting in the town has been carried out by the Corporation. The profit from this goes towards reducing the loss at present incurred in supplying the light. A suitable showroom at the gas offices is well stocked with the best of everything obtainable in the way of fittings.

The whole of the work has been carried out by the Brush Electrical Engineering Company, Limited, with the exception of the erection of the buildings and engines, under the combined superintendence of Mr. Raworth, their manager, and Mr. Geipel, their superintending engineer, assisted by Mr. J. J. Steinitz, as resident engineer. The general supervision of the station has been in the hands of Mr. Alfred Colson and his assistants.

THE TELEPHONE IN RURAL DISTRICTS.

In a letter to the *Times*, General Webber pleads the cause of the telephone in rural districts, "from the point of view of the 'continued seriously depressed condition of agriculture,'" and sets forth some of the advantages of a complete telephone service through the establishment of a call office in nearly every parish. By means of these call offices he anticipates that farmers would be able to converse with salesmen, saving journeys, and avoiding the useless movement of stock and produce; the village tradesmen would be able to promptly replenish small stocks, and the inhabitants to converse with the shopkeepers in the market towns for their larger purchases; whilst to dealers in perishable articles the value of the advantage is, he thinks, not easily computed. Going beyond the trading part of the question, he sees further advantages in the distribution of labour; the summoning of fire engines and ambulance aid; and "the administration of the executive duties of the County Council." General Webber estimates that for £49,000, exchanges in 29 towns, and call stations in 415 villages can be established, the cost of the exchange lines being excluded. The working expenses would amount to £12,200 per annum, and would be covered by an average income of 1s. 11d. per day from each call station. The county administration would have all the benefit to their own work for nothing, and the net result of the revenue from the private (? exchange) lines would be profit. In conclusion, General Webber says that it is a question for the Parliamentary Committee to consider "how far such a scheme would fit into the existing postal telegraph system, or interfere with or help it." We fear there is not much chance of the scheme fitting into the telegraph system; not much danger of its interfering with it; and little chance of its helping it. An agricultural county suffering from depression is hardly likely to spend £50,000 on the establishment of call offices without some evidence of their being remunerative. A call office is a very one-sided arrangement. Its utility to the caller is dependent upon his correspondent being already connected with the exchange, and it is useless as a means of initiating communication in the other direction. The communication between farmer and salesman on market days has become an institution which is something more to the farmer than the mere transaction of business, and no telephonic communication can take its place. The occasions for other conversations are not general, and it must be something more than a rural call office which will produce 1s. 11d. in twopenny messages for each of six days in the week. Leaving the farmer, we fear that even General Webber's statement of the case will not carry conviction of the value of the means of communication to the village tradesman. The prompt replenishment of stocks would be unnecessary when the inhabitant gets his goods direct from the market town. General Webber's scheme has the appearance of being forced, and is altogether overdrawn. It suffices to say that improved means of communication are valuable, but they must be provided on reasonable and remunerative lines.

International Electrical Conference.—A French Exchange says that the Comte de Montebello, French Ambassador at St. Petersburg, having in the name of his government proposed to the Russian Government to take part at the International Conference for the establishment of units of electricity and of light, similar to the project elaborated in the conclusions of the technical commission which had recently assembled in England, the Academie des Sciences of St. Petersburg, which the Russian Government had consulted on this subject, has declared that the participation by Russia in this conference is very desirable, from both the scientific and practical points of view.

BUSINESS NOTICES, &c.

[*Continued from page* 504.]

Bristol Electric Tramways.—The Kingswood Urban Council at the last meeting passed a plan received from the promoters of the Bristol Electric Tramways, which showed where they proposed to affix the poles for carrying the overhead wires.

Grove v. Ford-Lloyd Manufacturing Company, Limited.—This debenture holder's action came before Mr. Justice Vaughan Williams, in the Companies Winding-up Court, on Wednesday, Mr. Wilkinson, counsel for the plaintiff, asking for judgment in default of defence. The company, the learned gentleman said, was incorporated as a firm of electrical engineers in January, 1893, and on June 12th they issued to the plaintiff a debenture for £1,000 which he paid for in cash. That debenture was now due, and the company had since issued others, charging all their property and assets with the amounts thus raised. His Lordship had already made a compulsory winding-up order in the case, and the Official Receiver, as liquidator, had not thought it necessary to appear in answer to the present action. He put in an affidavit to the effect that it was desirable to realise the machinery, tools and effects, of the undertaking, and asked that an order might be made directing an account to be taken and an enquiry as to the priorities of creditors, the compulsory order being continued with the Official Receiver as liquidator, and liberty to apply. No one appearing to resist the application his Lordship granted it in the form asked for.

Holborn Restaurant.—We have received a tastefully got up and nicely illustrated pamphlet which shows the palatial rooms of the Holborn Restaurant. One of the pictures shows the electric light installation.

Hunnings Transmitters.—During the last few years Hunnings telephone transmitters have made great strides in general favour, both in Europe and America, and at the present time they are universally acknowledged as one of the best and most powerful transmitters known to the electrical world. Messrs. Cox-Walkers, electricians, of Darlington, have made great improvements in them recently, and are manufacturing large numbers for all parts. Some of those made in 1878, '79, and '80 are still in daily use, giving excellent results.

Proposed Electric Tramways at Halifax. — The Mayor of Halifax at a local banquet the other day in speaking of tramways, said that he, along with the Town Clerk when in London, called upon a firm of electrical engineers who said that if the corporation would lay down the rails into the different suburbs of the town, they would be prepared to rent the lines and find the rolling stock, provided the corporation would only pay a fair rate of interest for the money laid out. Under these circumstances an opportunity would probably be given at the next council meeting of offering an opinion as to whether or not it was desirable that a system of tramways should be initiated.

Transmission of Power.—Messrs. Johnson & Phillips are at present engaged putting down plant for the transmission of power to the Cefn Coch Mine, in Wales. The plant will supply power to the machinery at this mine as well as to two other sets close by.

CONTRACTS OPEN.

Belgium.—May 1st. The last date for the receipt of tenders invited by the municipal authorities of Tongres (Leinburg Province) is Wednesday next, May 1st.

Brazil.—The municipal authorities of Saint Jean-del-Rey, Brazil, are at present inviting tenders for the electric lighting of the town.

Brighton.—May 13th. The Borough Council are inviting tenders for India-Rubber lead-covered cables. Further details can be obtained from our advertisement pages.

Brighton.—The Brighton and Rottingdean Seashore Electric Railway Company invite tenders for accumulators for use on a large car. See our advertisement pages for details.

Brighton.—May 13th and 27th. The Corporation invite tenders for arc lamps, &c., and boilers. Further particulars will be found in our advertisment pages.

France.—May 25th. The Prefecture of Saint Lô, at Cherbourg (Manche), is inviting tenders for the operation of electric tramways in Cherbourg.

Germany.—May 4th. The Telegraph Department of the Saxon State Railways, in Dresden, is inviting tenders for the supply of porcelain insulators, wires, and other telegraphic apparatus, as stated in detail last week.

La Plata.—The La Plata Telegraph Department is calling for tenders for supply of telegraphic materials.

Londonderry.—June 1st. Tenders are being invited by the Corporation for carbons. Details to be obtained from the town clerk, Mr. R. Chambers, at the Guildhall.

Portsmouth.—April 29th. Tenders are invited for wiring and lighting by electricity (1) the Corporation stables, Landport, (2) the fire brigade station, Landport. Particulars to be obtained at the Town Hall.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Shoreditch.—May 20th. Tenders are invited for dust destructor furnaces for electricity supply. See our advertisement pages for details.

Wakefield.—We understand that tenders are to be invited for electric lighting works here.

CITY NOTES.

The County of London and Brush Provincial Electric Lighting Company, Limited.

The annual general meeting of this company was held at Cannon Street Hotel, E.C., on Monday last, to transact the ordinary business of the company.

The chair was occupied by the Right Hon. D. R. Plunket, Q.C., M.P., who, in moving the adoption of the report, said: This is the first annual report which we have had to submit in the history of this company, and I have the honour of asking you now to adopt it, and I make that motion on behalf of my brother directors as well as myself. It is true that last autumn we submitted to you a statement, but that was rather in the nature of a preliminary statement, and this is the first occasion on which we have been able to show you a report of a full 12 months' experience of the working of this company. I think, and I hope you will agree with me, that the position in which we find ourselves after such a brief experience is eminently satisfactory. In the first place, looking at it from a financial point of view, which, after all, is the most important for us as shareholders and also for our customers, you will see that on the profit and loss account, after providing for all the usual charges, and after writing off the preliminary expenses in connection with the negotiations of the Canterbury companies, which did not produce any substantial result—that only amounts to about £300—we are able to submit to you a profit, a very small profit, I admit; but still, at the end of only 12 months' working, I think it is a satisfactory circumstance that we are able to show you a small profit on the operations of the company. You will see that the capital expenditure is proportionately rather heavy, but that is not a matter of regret at all, when you consider the purposes to which that expenditure has been applied—in fact, we are only sorry that we have not had opportunities of making a larger number of investments up to the present time of the same kind. But there is one circumstance which I think, looking at it still from the financial point of view, we can regard with peculiar satisfaction, and that is the circumstance that a short time ago we found it necessary to apply to the public for money for the purpose of meeting the expenses of contracts we had entered into, and also of paying for shares of certain companies over which we had obtained a controlling influence, and when we made an issue of 10,000 preference and 10,000 ordinary shares of £10 each, that issue was immediately taken up and subscribed many times over. I think all these are symptoms we may fairly claim establish a satisfactory position of our company at the present time, and I think it is not only satisfactory to ourselves that we should find ourselves in that position, but I think it may also give an additional inducement to private persons who may think of taking an electric supply from us, and also it ought to be an encouragement, and give confidence to any electric light companies, who not having had the fortunate experience in their early history that we have so far had, may now desire to recover their position by alliances with us, and you may rest assured that the directors will take care that the basis of such alliances will be thoroughly safe and favourable to your interests, and, indeed, as you know, we have already had some experience in dealings of this kind. But before I refer to our experiences in acquiring a controlling influence over other existing companies, let me say a word or two as to the present position of the company as regards those enterprises within the circuit of the county of London. No doubt we have been met with some delays in this business which have been caused mainly by the objections which have been made by the London County Council and other local bodies to the proposals—not, I beg you to observe, from any faults they have detected in the system of electric lighting which we submitted to them—but on account of unfortunate circumstances which have lately happened in connection with the operations of other companies, and thus the Board of Trade have, for the moment, yielded to the objections thus taken by the County Council, and by other local authorities, in order that they may fully possess themselves of all the circumstances of the case before giving their assent. I do not think we can very seriously complain of that, because no doubt a certain amount of distrust, and even of apprehension, has been caused in the public mind by the unfortunate circumstances which have occurred elsewhere; but I wish you to understand that these accidents have not occurred in systems similar to those we propose to use in street boxes, &c., but still they do account for the delay which has, so far, occurred. I think it is a satisfactory circumstance which I may mention to you—and special reference was made to it last week by Major Cardew, the very careful and able representative of the Board of Trade, in regard to the result of the accidents which have

occurred in electric lighting in London—that you will be glad to hear that our excellent engineer, Mr. Lawson, assures me that the system which he is prepared to submit, and which, as a fact, he has been for some time contemplating, and is now carrying out, will not be open to the objections in Major Cardew's report, and will meet all the requirements he set forth, and therefore you and the public may rest assured that we shall be able before very long to carry out the supply of electric current to our customers, with perfect safety to them and to the public. In fact, we have already obtained the assent of the local authorities in the district of St. Luke's, Clerkenwell, to this extent—that we have been able to lay pipes for our mains throughout all that district, and make our arrangements for street boxes. I believe all those are satisfactorily arranged in that district, and as you know, we have commenced the building of the power station which we propose to establish at the City Road basin of the Regent's Canal. We hope that that will be completed in sufficient time for supplying the current from that station by the end of September, and then we shall be ready for the period of the year when days are short and the nights are long. Then as to Wandsworth, our operations have been delayed a little pending the publication of the regulations of the Board of Trade, but we have good reason to expect that they will now be almost immediately issued. We have in the meantime been fortunate enough to acquire a large supply of pipes for our mains at prices which compare very favourably with those now ruling in that business, and we shall be ready to proceed at once with the laying of those mains, and I hope there will be no more serious delay in that quarter. We have acquired a site on the southern bank of the Thames for the Wandsworth district, and the completion of the buildings is far advanced, so that we hope they will very soon be finished. We have also now obtained the consent of the local authority in the district of St. Olave's, Southwark. This is an important district, containing the two London Bridge stations and the railway approach, and it will be a favourable operation for us because that district adjoins the district of St. George the Martyr, where we have already obtained a provisional order, and so we shall be able to work the two districts together from one generating station, and by this economy of staff, and the concentrating of our arrangements, I hope we shall be able to conduct the station under economical and favourable conditions. Those are, I think, all our operations in the county of London; and I will now turn to enterprises which we have begun outside the county. Let me first deal with the Bournemouth Company. A year ago we acquired from the Brush Company their interest in the local Bournemouth Electric Lighting Company, and I am glad to tell you that our advance and the improvement in our position in that quarter has since that time been very remarkable indeed. There has been a great increase in the number of consumers—so great that it is represented by an addition of 4 500 8-candle-power lamps, making 19,000 altogether up to the end of last year. Of course we have incurred some additional expenditure in order to carry out this increased service, but it has been in a way that any further demands upon us can be very economically met. I may mention, as illustrative of the advantageous circumstances under which the proceedings of this company are now conducted, that within the first three months of the current year there has been an increase of, I think, 20 per cent. of the current supplied as compared with the amount supplied in the corresponding period last year, and at the same time Mr. Lawson informs me that by very economical arrangements of the plant there has been a considerable decrease in the expense of coal, calculated per unit of supply. But we have not nearly come to the end, I hope, of the development of the Bournemouth operations, and it is estimated that whereas at the present time the capital outlay per each 8-candle-power light we supply is represented by about £2 15s., as the development of our business there goes on, and we attain, as we hope to before long, a business represented by 40,000 8-candle-power-lamps, we trust to see the capital cost reduced from £2 15s. to something like £2 5s. Then as to Dover. There the building of the generating station, and the offices connected with it, is completed, and a very fine station and set of offices we have there. We have thus acquired what I believe will turn out to be a very valuable business. Up to the present the whole of the plant has not been delivered, but with such plant as we have there we are already supplying light to the sea front, and we have laid our mains through the business part of the town, and with very little additional expense we shall be able to lay them through the residential part of the town also. Last week I had the pleasure of meeting Sir William Trundle, our very energetic chairman of the Dover Company, and Mr. Bagshawe, and I went over the whole of our arrangements with them, and I think you may feel very comfortable that with their wise and able assistance we shall be able to make this enterprise a very satisfactory and remunerative one. Then as to Windermere. There we have so far succeeded in obtaining the assent of all the local authorities, excepting two, for the application for a provisional order we desire to obtain for that district; that is to say, we have obtained the assent of seven towns out of nine, and we hope that the two outstanding ones will before long see the advantage of joining the others in taking the electric light for their towns, which we shall be able to offer them on very moderate terms, by reason of the advantage we have of obtaining the water supply from a river there. Then coming to Richmond, in Surrey, that is the last investment we have made. There we have acquired—I may say when we were drafting this report the negotiations which had been some time in progress were practically completed, but now they are actually completed—and so we have acquired at Richmond an excellent generating station, supplied with admirable plant, and we have obtained an interest in a going concern which already supplies upwards of 4,400 lights in the town, and we have obtained an interest in it which I think will turn out to be a very favourable investment. I do not think anybody who goes through that picturesque town can fail to see the large number of fine houses and large hotels and other business premises which it contains, and no one could deny that its handsome streets and terraces would greatly gain in appearance if electric light were introduced into them. I can very well understand that the people in Richmond have hesitated up to the present making applications for electric lighting to the existing company on account of the various difficulties in which it was unfortunately involved; but now that the company stands practically on a firm financial basis, and that people there can rely upon obtaining the completion of any contracts they enter into with us, I hope the demand for lighting will become very brisk; on the part of the company, I can promise that we shall be ready to go half way to meet customers who wish to take the current from us, if necessary by additional mains in carrying current into districts which are not at present served by them, and giving all other facilities which can be reasonably asked of us. As to this Richmond station, having carefully gone over it only last week, I am very sanguine that our latest investment will be a very favourable one, and will turn out very profitable. I have only to add that, as regards the matter of electric traction as applied to tramways, we have had proposals from one or two places upon the subject, and we are of opinion that there is a probability of considerable scope for the development of such electric enterprise in this country. We are carefully considering the matter. Up to the present we have not had any offer which we thought it well to close with, but we shall be very ready to carefully and favourably consider any further proposals of that kind which may be made to us. Under these circumstances I have now to propose, "That the report of the directors and statement of accounts to December 31st, 1894, now presented to the shareholders be received, and that the same be hereby adopted."

Mr. J. B. Braithwaite, Jun., seconded the motion, which, after a brief discussion, was agreed to.

Mr. G. Herring called attention to the fact that, by an error in the articles of association, provision was not made, as in other similar companies, for an increase in the directors' remuneration, and he proposed that there should be an increase.

Mr. Cash, and several other Shareholders, took exception to the proposal, on the ground that the meeting was a small one, and it would be scarcely fair to bind the whole of the shareholders to a permanent increase in the remuneration of the board.

Mr. Herring said he had no wish to press the matter on the meeting, and he would bring the subject before the next meeting.

After the re-election of the retiring directors and auditors a vote of thanks to the chairman concluded the proceedings.

Eastern Extension Telegraph Company.

The report of the Eastern Extension, Australasia and China Telegraph Company, Limited, for the latter half of 1894, states that the gross receipts, including Government subsidies, amounted to £261,323, against £251,698 for the corresponding period of 1893. The working and other expenses, including £29,791 for cost of repairs to cables and expenses of ships, absorbed £89,741, against £76,575, leaving a balance of £171,582. From this are deducted £4,585 for income-tax, £31,895 for interest on debentures, debenture-stock, and contribution to sinking fund, and £1,372 for celebrating the 25th anniversary, leaving as the net profit £133,730, which, with £68,457 brought forward, shows an available balance of £202,187. A quarterly interim dividend of 1¼ per cent. has been paid, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the June six months, a total dividend of 5 per cent. for the whole of 1894. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., for the year, making a total distribution of 7 per cent. The balance of £89,687 has been carried to the general reserve fund, which, after being credited with interest received during the half-year and profit on sale of investments, and debited with £100,000, part cost of the new Singapore-Hong Kong cable, now stands at £641,599. In accordance with the provisions of the trust deed 389 of the 5 per cent. Australian Government subsidy debentures, amounting to £38,900, were drawn by lot on April 1st for payment at par on July 1st next.

The Oriental Telephone and Electric Company, Limited.

The directors in their report state that the shareholders will recollect that the company was formed on the 12th March, 1894, to take over the property and assets of the old Oriental Telephone and Electric Company, Limited, the object in view being a re-arrangement of the capital account of that company. In order to avoid any dislocation of the business and complexity of accounts, the latter have been continued as from December 31st, 1893, the result being a net profit for the year of £8,729 4s. 9d. As was intimated to the shareholders at the meeting held on March 12th, 1894, a dividend on the present occasion can only be declared for the period from the date of incorporation of the company to December 31st, 1894. Under the advice of the auditors, therefore, the directors have apportioned £7,031 4s. 6d. of the above sum as being the profit available for disposal. They propose to deal with this amount as follows:—To write off £453 17s. 10d., being the whole of the preliminary expenses incidental to the formation of the present company, to pay a dividend at the rate of 4½ per cent. per annum, free of income tax, for the period from March 12th to December 31st, which will absorb £5,871 1s. 5d., and to carry forward £706 5s. 3d. The general business of the company has on the whole been satisfactory, and the electric lighting branch inaugurated by the old company shows prospects of assisting the revenue of the company in the early future. The Bengal and Bombay Telephone Companies have paid improved dividends for the past year, whilst the Telephone Company of Egypt, the capital of which is almost entirely held by your company, has made good progress. The

accounts of the China and Japan Telephone Company have not yet been closed, but owing to the low rates of exchange ruling, the net revenue of that company, after payment of debenture interest, will show less favourably than in the previous year. Under Article No. 65 two directors retire at the present meeting, and these are Mr. William Addison and Mr. Thomas Lloyd, who, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., appointed by Article No. 89, also retire, and offer themselves for re-election.

The Great Northern Telegraph Company of Copenhagen.

The general meeting of this company was held at Copenhagen on April 20th, 1895, when Mr. F. Zahle, presided.

In the absence of the chairman, the managing director, Commodore E. Suenson, R.N., gave an account of the working of the company during the year 1894, and among others made the following remarks: The year 1894, which had seen the celebration of the 25th anniversary of the formation of the company, had also been the jubilee year of some of the cables in Europe. The Scotch-Norwegian cable, the Russo-Danish, and one of the Russo-Swedish cables, were all three opened for traffic in 1869. Two of the cables were older still; the Anglo-Danish, laid in 1868, and the Danish-Norwegian, opened in 1867. It was true that in the course of years the latter had been renewed from end to end, but, old as some of the cables were, their condition was still satisfactory, thanks to the care taken to renew and strengthen defective portions. During the year six of the cables in Europe had been subject to 13 interruptions, and in the Far East there had been nine interruptions of five of the cables. The cable steamer *H. C. Orsted* had been employed on active service for 115 days; the *Store Nordiske* for 127 days. The Wladiwostock line, which runs through Russia and Siberia, connecting European with the Far East cables, had worked less satisfactorily than usual. Various suggestions for the improvement of the service were now under consideration. After referring to other matters, the speaker said a circumstance that had particularly contributed to the success of the jubilee year was the fact that, compared with the 24 preceding years, it had shown the highest receipts, surpassing even the year 1891, which hitherto had been the best. This satisfactory result was due almost exclusively to the increase of the traffic in the Far East. The increase in receipts did not arise from the normal traffic, with regard to which the observations made last year still held good in every respect, the disproportion between the increase of work and the receipts being as great as ever. The fact was that the increase in the receipts in 1894 came from an altogether extraordinary source, viz, the war between China and Japan. The company had maintained an amicable, but strict, neutrality towards the two belligerents. Thanks to this attitude, and to the indispensable necessity of the telegraphic connections, neither of the two Powers had interfered with the cables. The service had been performed as regularly as in time of peace, and it is a remarkable phase of this Oriental war that, as in the war between France and China in 1884-85, not only the international cables, but also commerce and navigation, had been left undisturbed.

The report was then adopted.

The Medical Electrical Institute, Limited.

The statutory meetings of the creditors and shareholders of this company were held on Tuesday, at Carey Street, W.C., before Mr. C. J. Stewart, Official Receiver.

In the course of the proceedings, the Chairman stated that the company was registered on October 16th, 1894, and was formed for the purpose of carrying on the business previously carried on by the Medical Battery Company, Limited, for the sale of medical and electrical appliances. The last-mentioned company had a winding up order made against it in November, 1893, and subsequently a reconstruction scheme was approved, of which the present company was the outcome. The capital of the company was fixed at £75,000, of which £50,000 ordinary shares were to be issued as fully paid to the shareholders of the old company, and £25,000 preference shares were to be issued to the creditors of that company if the admitted claims amounted to that sum. Various directors were appointed, and Mr. Harness was appointed manager at a salary of £600 a year. The only shares which had been allotted were those of the seven signatories to the memorandum and articles of association. First debentures to the amount of £2,790 had been issued, and under the terms of the reconstruction scheme other debentures were to be issued, forming a charge of £6,650 upon all the assets of the company subject only to the first debentures. There was a large number of creditors who had lodged proofs against the old company, and owing to the nature of the claims, which were to a great extent in respect of advertisements, some difficulty was experienced in expeditiously dealing with the proofs. While steps were being taken in that direction it became apparent that the new company was not in a position to carry out the terms of the scheme of reconstruction, and in January last a receiver was appointed, who took possession of the assets on behalf of the debenture-holders. Upon the commencement of business by the new company advertisements were inserted in various newspapers upon a considerable scale, in the hope that the public demand for the medical and electrical appliances sold by the company would greatly increase, it appearing that the former prosperity of the company was in a large measure due to a system of extensive advertising. In that hope, however, the board were disappointed, as the advertisements did not apparently produce sufficient business to pay expenses. To that fact, and to want of funds to carry on the advertising for such a length of time as might possibly have rehabilitated the business, the failure of the company was attributed. The accounts which had been filed showed unsecured debts £1,363, other liabilities £648, loans on debenture bonds £9,440, and preferential claims £186. The assets disclosed were stock-in-trade, machinery, &c, £5,000, and goodwill of lease £1,000, the whole being covered by the debenture bonds. The deficiency was £5,630, and it was clear that there would be no dividend available for the unsecured creditors. No resolution was passed with regard to the appointment of a liquidator and committee of inspection, and the chairman intimated that the matter would remain in his hands to be wound up in the usual manner. In reply to a creditor, it was stated that no fees had been paid to the directors, and that a sum of £250 was due in respect thereof.

The Metropolitan Electric Supply Company.

The eighth ordinary general meeting of the shareholders of the above company was held on Wednesday at Winchester House, Old Broad Street, Sir John Pender, G.C.M.G., M.P., presiding.

The Secretary (Mr. E. Cunliffe Owen, C.M.G.) having read the advertisement convening the meeting, the report and accounts were taken as read.

The Chairman, in moving the adoption of the report, said: It will be most convenient to deal first with that portion of the accounts which shows the growth of our undertaking. From the capital account you will have seen that we have expended in connection with our works of construction a total sum of £42,999. Of this amount about £30,000 have been spent on mains, transformers, connections and meters. This represents the ordinary extension of our business in supplying the new customers who have been connected to our system, as well as making provision for future customers in our various districts. So long as customers continue to increase at their present rate, and the areas occupied by us have to be filled up with the necessary network of mains, this expenditure must continue to grow, while every addition means the growth of profitable business to the company. The other items of capital expenditure requiring notice are buildings, £1,832, machinery £7,995, and compensation £2,703. Dealing with these in the order named, the first item is due to work for the completion of the new foundations at our Manchester Square station, to which I referred last year, and also to expenditure at our Amberley Road station at Paddington, in providing for the reception of additional plant to enable us to keep pace with the needs of the district. The second item (machinery) is due to new plant which has been erected at Manchester Square station to meet the circumstances under which we have been placed in connection with the actions brought against us for vibration. This seems a fitting place for referring to the difficulties we have encountered in this matter, difficulties which have required our most earnest care, and which have taxed the skill and energies of our staff to overcome, and we are much indebted to my old friend, Lord Kelvin, to Prof. Kennedy, and to many others, for the assistance they have rendered to us in the matter. Some considerable time was necessarily occupied in carrying out the remedial measures, and it was found impossible to avoid litigation, which took the form of actions for injunctions to restrain the company from carrying on their works in such a way to cause a nuisance. There were practically three of these actions, for though a fourth was commenced very recently, it was soon discontinued, and the plaintiff had to bear his own costs, and although there is still a small question about alleged noise with the plaintiff in another of these actions, so far as vibration is concerned, all the actions have been disposed of. We therefore may, I think, regard our difficulties as practically overcome at Manchester Square, for of the three outstanding actions, in one case the plaintiffs admit that there is no vibration; in the second, no steps have been taken for about a year, so I think we may assume they have arrived at the same conclusion, while in the remaining action it only remains to ascertain what damage the plaintiffs have suffered directly attributable to the vibration. It was, of course, impossible for us to carry out the remedial works, involving, as they did, alterations of foundations and changes of machinery, without serious expense and great difficulty in maintaining a constant and regular supply. Moreover, our working expenses show a large increase in consequence of our other stations having been called upon to assist the Manchester Square works almost daily during the alterations. I ought to explain that the machinery which was thrown out of use from the above causes is doing excellent work elsewhere, so that we are now possessed of additional plant which it would have been in any case necessary to obtain to cope with our largely increasing output. You will now, I think, quite realise the nature of the third of the items (namely, compensation) to which I have directed your attention in the capital account. It relates entirely to payments made in connection with these law suits. The capital expenditure during the year naturally involved the provision of funds to meet it, and in dealing with this question the board considered that they ought to be able to borrow on better terms than 5 per cent. In the result a first mortgage debenture stock at 4½ per cent. was created to the extent of £250,000, of which amount £150,000 was issued last July at 105, that being the rate at which the old debentures had to be redeemed. With the proceeds, the whole of the old debentures have been paid off, and the net premiums have been carried to the depreciation fund. You will notice that I have said net premiums, as there were expenses of issue to be paid and interest to be paid and interest to be provided for during the period which had to elapse before the whole of the old debentures could be called in under the terms of which they were created. Of the balance of £50,000 which was left, we had £21,000 still in hand at the end of the year, but it will before long be necessary to make a further issue to keep pace with our rapid expansion of business. I now ask you to turn to the revenue account, which shows a steady increase, being £16,150 more than in 1893, and an increase of £7,000 in the gross

profit. This increase, satisfactory though it is, would have been larger had it not been for a somewhat heavy increase in working expenditure, partly owing to the higher price we had to pay for coal, but also to a very large extent in consequence of the peculiar difficulties which the litigation to which I have already referred forced upon us. These difficulties having been successfully overcome, as we believe, will not trouble us again. I ought also to point out that, as mentioned in the report, the board found it absolutely necessary to make certain reductions in favour of large consumers of current. While, up to the present time, we have been able to maintain our standard price at sevenpence farthing per unit, a reduction is made after a certain fixed minimum has been reached. This reduction has been largely taken advantage of by our more important customers, especially during the winter quarters, but while our receipts have been materially affected thereby, the encouragement which this system of charging gives to use our current is beneficial, as having a tendency to increase our day load. I would also remind you that in one portion of our district competition has to be met. The final result, as shown in the net revenue account, is that after writing off the usual £1,000 from the preliminary expenses, and setting aside a further £8,000 to depreciation, there remains a balance of £15,909, out of which the board propose to pay a dividend of 6s. per share, carrying forward £939 to the next account. Referring to the amount written off for depreciation, and to the auditors' note upon the subject, I ought to say that the board do not in any way commit themselves to an opinion as to what amount should be written off on this account. They recognise the fact that electric lighting is a business which is at present new, but being gradually developed, and as such cannot be judged altogether by the experience of other business, while the knowledge which is being gained year by year may show at some future time that the amount set aside is insufficient; it may, on the other hand, be found that it has been larger than is actually necessary. Having regard to the interests of the present shareholders, who have taken all the risk of the establishment of the undertaking, the board have thought, after the most careful consideration, that an appropriation for the purpose in question, increasing with the company's income and practically proportional to that income, will most justly and reasonably meet all the requirements of the case. Now, gentlemen, I have put all these statements on paper because it is necessary that you should have a very correct and very careful account of the proceedings of the business during the year. I have only received one letter rather complaining that the dividend was somewhat smaller than was expected. I have received on the other hand a letter which highly approves of the policy in declaring a moderate dividend. Therefore I have to say to you, and I daresay I am speaking to many who are partially disappointed that our dividend is not larger than it is, when I see the cases which come before me daily as to the reason, I am satisfied that we are pursuing a sound policy in building up, as we are doing, the business on a thoroughly sound basis. I may mention that when we originated this business we were under the impression—showing how uncertain these things are—that at least £1 per light would be gathered from our customers, and a gentleman told us that we were considerably undervaluing it, and should say 25s. per light. I need not tell you that if we were getting that value per light which we contemplated when we first issued our prospectus, we should be paying a very different dividend than we are paying. The average of each light now is 8s. 5½d. But that does not disappoint me, because I see the growth of the concern in the increasing demand, which is a continuing and steady one. To-day we have about 224,829 lights, and we have still on demand 10,000, and as far as I can see, we, with our present machinery, will go on up to something like 300,000 lights. One reason for our not paying so large dividends as one or two of the existing companies, is that we have a much larger area. We have to lay down mains over a very considerable space, and these lines are laid at a very considerable expense, and we are beginning to get along those lines, and when there is a full demand for our light then the company will begin with no increase of expense to realise what they are sowing at the present time. I therefore look forward to our dividend steadily increasing. I think we are building up this business on such a sure foundation that those who are in it now will have no cause to regret their association with us. We originally expected to hold the Westminster district, but the Board of Trade has the power to make the allotments, and we were obliged to take the allotments made to us, and we are hopeful we shall work out these allotments so as to extend over a greater space of time and get it firmly established, and be able to meet the demand for the electric light the popularity of which is increasing daily. I cannot tell you the trouble we have had about this vibration. We have been attacked on all sides. Many people expected to get something out of us, and many people had the firm belief that their property was being injured. Well, we have been forced to go into it very carefully, and the result has been that we have got now such improvements in our machinery that we have been enabled to introduce a power which has answered our purpose, and I may say that out of these troubles which we have gone through we expect results which eventually will be beneficial to the company. With regard to this reserve fund, as I have told you, ours is a new business. We want to be perfectly safe in what we are doing with regard to our depreciation fund, and as far as I can make out, we are on the safe side; but I see our very careful auditor here, and he, in these days when a man is called to account for his words, is anxious to show that this company is a new business, and that the amount placed to depreciation is very considerable. The experience of 20 years will show whether we have put aside a sufficient sum for depreciation. I will pay this compliment to our engineer and executive, that we have a thoroughly efficient staff, and we have very proper and efficient discipline amongst that staff. The complaints that we have had have been comparatively nothing, and I may tell you that whilst the slightest interference disturbs the lights, these disturbances could not have been frequent, or we should have had many complaints. Therefore I look upon the fact of our going on so quietly is that the relations which exist between ourselves and our customers are satisfactory. The reduction of rates was very considerable, but where there is competition we have had to meet it; but I think the day will come when I think it will be understood that that competition will not be pressed as at the present time, and I think, when we get to understand our business better as to the cost of working, we shall be better able to come to an understanding with the respective companies to work in the same direction as ourselves, and I am glad to say that these companies do look on us as rather an example in the way our business is conducted. Our managing engineer has been invited to give his services to another important company. We value his services greatly, and we can test the result of his management in the way the business has been conducted. We therefore came to an arrangement with another company, that while we retained the services of our engineer, that we would allow him to confer with them and to give them the benefit of his experience to put their establishment into, I hope, as good a position as our own. The members of our staff are all selected men, who thoroughly understand their business, and without going further into detail, I think I may say of our company that we stand well with our customers, we stand well with the public, and we ought to stand well with our shareholders, because while our dividend is not large, it is based upon the soundest business principles, so that you have the prospect of a steadily increasing dividend. Our business is a steadily increasing one, and therefore it must result in its income growing, and I hope the expenses will not grow in the same proportion. He then moved the resolution.

Sir George H. Richards seconded the motion.

Mr. Young congratulated the directors upon having effected a considerable reduction in the management expenses. Last year they stood at 11·5 per cent. of income, but now they were only 9·8 per cent.

Mr. Cripps suggested that the time had come when the shareholders should receive their dividends half-yearly.

The Chairman said he considered the proposition a reasonable one, and, as a matter of fact, the directors had talked it over several times. If they were to hold half-yearly meetings it would add considerably to the expense, but as soon as the directors found themselves in a position to pay interim dividends, they would be glad to do it.

The report was then adopted.

Admiral Lord John Hay, G.C.B., proposed the re-election of the retiring directors—Admiral Sir George H. Richards, K.C.B., Sir E. M. Shaw, K.C.B., and Mr. J. B. Verity.

Mr. J. C. Parkinson seconded the motion, which was agreed to.

The auditors having been re-elected, a vote of thanks was passed to the chairman for presiding, and the proceedings terminated.

The City of London Electric Lighting Company, Limited.—The revenue return for the quarter ended March, 1895, is as follows:—Revenue from sale of current for public lighting, quarter ended March, 1895, £3,191; corresponding quarter last year, £3,100; revenue from sale of current for private lighting, &c., quarter ended March, 1895, £26,622; corresponding quarter last year, £12,469; estimated revenue from other sources, quarter ended March, 1895, £340; corresponding quarter last year, £404; total, quarter ended March, 1895, £30,153; corresponding quarter last year, £15,964; increase, £14,189; equivalent of 8 C.P. lamps connected on March 26th, 1895, 148,594; increase during quarter, 13,134; equivalent of 8 C.P. lamps connected on March 26th, 1894, 84,634; increase during corresponding quarter last year, 19,293.

The European Sims-Edison Electrical Torpedo Company, Limited.—At an extraordinary general meeting of this company, held at 9, Fenchurch Avenue, E.C., on February 11th, 1895, the following extraordinary resolution was duly passed:—"That it has been proved to the satisfaction of this meeting that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the company be wound up voluntarily." Mr. T. D. Pillans, of 11, Sheen Park, Richmond, was duly appointed liquidator for the purpose of winding up.

The Submarine Cables Trust.—The report of the Submarine Cables Trust for the year ended April 15th states that the revenue, including £240 brought forward, amounts to £21,704. The expenses amounted to £1,194, and the payments on account of the coupons to £20,286, leaving a balance of £224 to be carried forward.

West India and Panama Telegraph Company, Limited.—Dividends of 6s. per share on both the first and second preference shares are recommended by the board for the six months ended December 31st last.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending April 21st, 1895, **amounted to £856; week ending** April 22nd, 1894, **£886; decrease, £30; total receipts for half-year, 1895, £15,219; corresponding period, 1894, £14,613; increase, £606.**

The Liverpool Overhead Railway Company. The traffic receipts of this railway for the week ending April 21st, 1895, amounted to £1,386; corresponding week last year, £682.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 19th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,808.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation April 17th.	Closing Quotation, April 24th.	Business done during week ended April 24th, 1895. Highest.	Lowest
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	101 —104	101 —104	...	...
1,012,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	41 — 43	44 — 46	44	...
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	78½— 79½	82 — 83	82⅜	79
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	6⅜— 7½	8¼— 8⅜	8⅜	7
130,000	Brazilian Submarine Teleg., Ltd.	10	6½ % §	6½ % §	...	12¼— 12¾	12¼— 12¾	12⅝	12 7/16
75,000*l*	Do. do. 5 %, repayable June 1906	100	5 %	5 %	...	110 —114	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	10% ‖ §	... §	...	3 — 4	3 — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	148 —152	148 —152	150	...
224,850*l*	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4 %	4 %	4 %	4 — 4½	3½— 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9½— 10	9½— 10	...	...
30,000*l*	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	2⅝% §	2 %	8⅜— 9¼	9 — 9⅜	9⅜	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	16¼— 16⅝	16¼— 16⅝	16⅝	16½
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	17¼— 17⅜	17¼— 17⅜	...	...
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	105 —108	105 —108	...	...
1,297,837*l*	Do. 4 % Mort. Deb.	Stock	4 %	4 %	..	124 —127	124 —127	126	125½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17⅛— 17⅜	17⅛— 17⅜	17⅜	17⅛
54,100*l*	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	}100	5 %	5 %	5 %	103 —107	103 —107	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	104 —107	104 —107	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	123 —126	123 —126	...	...
95,100*l*	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	}100	5 %	5 %	5 %	103 —107	103 —107	...	...
129,100*l*	Do. do. do. to bearer, 2,344 to 5,500	...	5 %	5 %	5 %	104 —107	104 —107	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	112 —115%	112 —115%	115	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	...	9⅜— 10	9⅝— 10⅛	10⅛	9⅞
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	...	16⅜— 16⅞	16⅝— 16⅞	16⅞	16⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜%	22 — 22½	22 — 22½	22¼	22⅛
190,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	106	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	52 — 54	51 — 53	53	52¾
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2½%	...	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	6 %	6 %	...	105 —109	105 —109	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	... — ...	... — ...	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	*nil*	4 %	...	1½— 2½	1⅛— 2½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	5 % §	5 % §	5 %	5½— 5⅝	5½— 5⅝	5 7/16	5 5/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15½— 16½	15½— 16½	16½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	15 — 16	15 — 16	15⅝	15 1/16
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	5 %	5 %	...	5⅝— 6	5⅝— 6	6	5⅝
1,100,000*l*	Do. 3½ % Deb. Stock Red.	...	3½%	3½%	...	104 —106	104 —106	105⅜	104½
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4½%	2/16 — 1 1/16	2/16 — 1 1/16	...	...
100,000*l*	Pacific and European Tel., Ltd 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	...	4 — 5	4 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	120 —125	122 —127	123	121½
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	85 — 90	85 — 90	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	0 %	...	4 — 5	4 — 5	...	...
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	98 —103	98 —103	99½	...
64,245	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3½%	9⅜— 10½	9⅜— 10½	10	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	5 %	5 %	5 %	6½— 6⅝	6½— 6⅝	6⅝	...
33,129	Do. do. do. 5 % Def.	7½	...	...	...	3¾— 4¼	3¾— 4¼	4⅛	...
171,900*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	6 %	6 %	6 %	101 —105	101 —105	...	...
214,800*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	6 %	6 %	6 %	101 —105	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅜%	⅜%	1 — 1¼	1 — 1¼	1⅛	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	6 %	6 %	6 %	11 — 11½	11 — 11½	...	...
4,669	Do. do. do. 6 % 2nd Pref. ...	10	6 %	6 %	6 %	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	5 %	5 %	5 %	109 —112	109 —112	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	115 —120	115 —120	...	...
166,900*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	101 —103	101 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5 — 5½	5 — 5½	5½	5⅜
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	13 — 14	13 — 14	13 1/16	13½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 15½	15 — 15½	15 2/16	15⅛
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —136	133 —136	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅛— 7⅜	7 1/16— 7 1/16	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	...	9⅜— 10¼	10 — 10⅛	10½	10
100,000*l*	Do. 5% Deb., bonds of £10, £20, £40	...	5 %	5 %	...	... — ...	... — ...	...	...
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	113 —120	118 —120	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	7¼— 7⅜	7¼— 7¼	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	7½%	4½%	6½%	7½— 8	7½— 8	7⅝	7⅝
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9	8½— 9	8 1/16	8 1/16
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	7⅜— 8¼	7½— 8	7⅞	7 1/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, April 17th.	Closing Quotation, April 24th.	Business done during week ended April 24th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 %	6 %	...	2½— 2⅝	2½— 2⅝	2 11/16	2⅝
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %	6 %	...	2⅝— 2⅝	2½— 2⅝	2⅝	...
125,000£	Do. do. 4½ % Deb.	Stock	4½%	4½%	...	113 —116	113 —116	...	...
630,000£	City and South London Railway	Stock	⅝%	⅝%	1¼%	45 — 47	45 — 47	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	2½— 3	2½— 3	...	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	5 %	5 %	5 %	100 —105 xd	no quotation	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	*nil*	*nil*	...	¼— ½	¼— ½	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1½— 1⅝	1½— 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	...	... — ...	... — ...	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1½— 1⅝	1½— 1⅝	1⅝	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1½— 1⅝	1½— 1⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½— 1½	½— 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	9½— 10½	9½— 10½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	21½— 22½	21½— 22½	22¼	21¾
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	101 —103	101 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	8 9/16— 8 11/16	8¾— 8⅞	8¾	...
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	14 — 14½	14 — 14½	...	...
	Swan United Electric Light, Ltd.	...	10 % §	7½% §	...	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	39 — 41	39 — 41	40½	39¾
150,000£	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	105 —108	106 —109	107	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2¼— 2½	2¼— 2½	2½	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.
Electric Construction Corporation, 6 % Debentures, 93—97.
Electric and General Investment, shares of £5 (£1 paid), 1½—2
House-to-House Company (£5 paid), 3½—4.
Do. do. 7 % Preference, of £5, 7½—7¾.
Do. do. 6 % Debentures of £100, 106—108.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7—7¼; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 6¾—7.
London Electric Supply Corporation, £5 Ordinary, ¼—½.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 99—101 nominal.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5¼—5⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

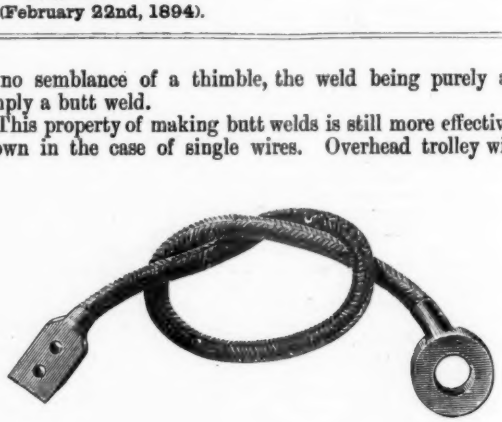
NEW FLEXIBLE COUPLINGS.

We have recently had the pleasure of examining some excellent examples of heavy couplings formed in a novel manner, which ensures a large section of stranded copper retaining the flexibility of the smallest wires composing it. It has been, hitherto, a very difficult matter to unite the ends of stranded conductors with solid terminals, or plugs, but the new process to which we are referring is completely successful in that respect, the joints are of great mechanical strength, and, what is more, the use of solder is dispensed with. It is scarcely necessary for us to dwell upon the disadvantages which were often met with when using the soldering and brazing methods, for besides often increasing the resistance of joints the introduction of another metal was sometimes responsible for setting up an electrolytic action. There need be no fear of such difficulties arising when adopting this new method of welding, for the weld is produced with pure copper in connection with the high conductivity copper wire composing the flexible coupling.

The method is one which has been originated by Messrs. W. T. Glover & Co., and we congratulate them on having made such distinct progress with the welding and working of copper. We understand that the process is not an electrical one, but we shall, no doubt, have an opportunity of saying something further about it at a more convenient period.

We give an illustration of a stranded copper cable, consisting of 2,200 strands of very fine wire which has been effectually welded to heavy couplings. In spite of the heavy nature of the cable (about an inch in diameter), and the great number of fine wires composing it, there has been no difficulty in gathering all the wires together and making a butt-ended weld. To us this is, perhaps, the most astonishing property of the welding process. One would have thought that to properly weld such fine wires to a heavy piece of metal a thimble would have been necessary, but we are informed, and certainly a careful examination corroborates this, that there is no semblance of a thimble, the weld being purely and simply a butt weld.

This property of making butt welds is still more effectively shown in the case of single wires. Overhead trolley wires



have been butt welded, and afterwards drawn, and there has been no sign of breaking, indeed it was difficult to tell where the joint was made.

There can be little doubt that this process will prove of great value, especially in cases where it is necessary to deal with heavy currents.

Acid Reaction of Sulphate of Zinc.—This salt, as purchased, almost invariably contains a considerable excess of acid. A sample carefully prepared with a view to ensure the neutral condition was found by Mr. G. C. Allingham to give an acid reaction with litmus but not with methyl orange. The solution of the salt was digested with zinc oxide for a month; at the end of which time it still gave a distinctly acid reaction with litmus. A knowledge of this fact, which has probably been observed by other experimenters, may obviate perplexity in making up the Clarke standard cell.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Discussion on Mr. Langdon's Paper.

(*Concluded from page* 491.)

Mr. W. Leonard said Mr. Langdon, in his preliminary remarks, referred to several railways which had adopted the electric light in its early stages, but he had omitted to mention the South Eastern Railway. He thought it was due to Sir Myles Fenton to mention that he was one of the first to recognise the advantages of the arc system of electric lighting in its application to railway stations, and the lighting of busy centres. The president would probably recollect that in 1881 he introduced a small plant at Bricklayers' Arms Goods Station. He thought that might be called the president's preliminary encampment, for it was practically a small tent with a temporary lighting plant, consisting of a portable engine and about four Gramme machines to light four arc lamps, and that, he believed, was in use for some considerable time. In 1882, the Brush Company started the lighting of the Charing Cross Station, and in the same year the British Electric Light Company took up the lighting of the Cannon Street Station, and those three stations had been lighted continuously from those dates up to the present moment. At Bricklayers' Arms they had now 26 10-ampère lamps of the Brush type and the Brockie-Pell, 12 outside and 14 in the sheds. The circuit extended three-quarters of a mile, and they had a Brush dynamo capable of lighting 40 or 50 lights. The lamps were switched on independently—first the inside lamps, 14 in number, and then the outside lamps, and in the morning they were switched out in the reverse order. The cost of running those lamps for last year was just under 1½d. per lamp-hour. At Charing Cross Station, after the Brush Company had given them notice that they wished to give up the lighting, they made arrangements with the Strand Electric Light Company to put in an installation. They contracted with Mr. Crompton's company, and the lamps are suspended from the roof in a very neat and tasty manner. Those lamps were supplied and maintained throughout at 5d. per unit, including the carbons, and he thought taking all things into consideration, particularly the value of space at Charing Cross, which was one of the difficulties in the way of their putting in an installation, and the fact that the lighting in the summer extends to only four or five hours a day, it would work out about as cheap as if they ran the lights from their own plant. At Cannon Street, following the same example, they had made arrangements with the City of London Electric Light Company to light the station, and their lamps had been running now for about six months. Theirs, of course, was the alternating current, but in each case they had arranged not only to divide the outside and inside lamps, but they had kept every platform distinct, so that the lights might be used as economically as possible, and when the platform was not occupied by a train the lights might be turned out. This was done both at Charing Cross and Cannon Street; in fact at Cannon Street one platform was not required after eight o'clock at night, and the lights were all turned out. This, of course, led to great economy, and taking all things into consideration would be found to answer their purposes quite as well as finding their own plant, and they had the great satisfaction of knowing that the supply was continuous, and could be had in foggy weather at any moment, which was a great consideration. Mr. Langdon mentioned that clear globes were not a success on the Midland. He might state that so far as they were concerned their lamps were placed higher and further apart than Mr. Langdon's, and they found that people very much preferred the clear globes when that was the case. He had no doubt that if a uniform generator could be supplied for arc and incandescent lighting there would be a good scope for contractors who could introduce such a plant, because one of the difficulties at railway stations was that a very small plant was required, and to have duplicate sets of arc and incandescent machines was a very great disadvantage.

Mr. E. Manville said what they sought now-a-days was practical information rather than theoretical, and it was such a paper as that of Mr. Langdon which gave them something on which in the future they might rely. A point which had struck him was that for all the extensive lighting undertaken by the Midland Railway, the candle-power of the lamps was kept down to that which was given by a maximum current of 10 ampères, many lamps, apparently, being only of 7½ ampères. He thought it was apparent to most of them who had had to do with lamps of higher candle-power than this, that even a comparatively small increase in the current taken by an arc lamp was productive of great extra efficiency in the light. He would refer particularly to an installation with which he was concerned for lighting the streets of Portsmouth, in which he believed, for the first time, lamps of 12½ ampères had been used. They felt, from their experience there, that an increase of current of from 10 to 12½ ampères had been of very great benefit to the general lighting of the streets. If that were so, he should think that for railway yards and open spaces of all kinds it would be advisable to consider in the future the adoption of lamps using a greater amount of current than 10 ampères. He was inclined himself to think that lamps of 12½ to 15 ampères would be far more advantageous for lighting such large open spaces. Mr. Langdon laid considerable stress upon the adoption of plants in which both arc and incandescent lighting, both extending over considerable areas, were supplied from the same plant. That was exactly what they had carried into effect at Portsmouth. The incandescent lighting was effected on the transformer distribution system with a low tension network, and from the omnibus bars of the station the arc lighting was also effected by means of transformers and rectifiers. These rectifiers, which he believed to be the first introduced for practical use in the kingdom, had proved themselves eminently satisfactory in meeting the conditions of series arc lighting, and they certainly had achieved by the use of such apparatus the great economy that could be effected by using one set of plant, consisting of a large number of units for both arc and incandescent lighting on the most economical basis possible. Perhaps in the case of a railway company commencing to do electric lighting, there was a tendency to creep before they walked, to put down small units of plant to light a few depôts or goods yards before laying themselves out to embark upon a larger scale in the same direction. This, he thought, was somewhat unfortunate, since in order to attain high economy in the end, it was essential that not a large number of small units of plant should be used for the purpose, but that a station laid out in the direction of the extensive use to which the light was likely to be put should be installed. Unfortunately, when a start was made in a small way as regards units used, there was a tendency not to increase much beyond these, and he fancied that in laying out such a station as that required by a railway company in a given town, it would be very advisable to start with a sufficient amount of lighting to utilise large units, so that the extension of the plant in the end might be carried out on the most economical scale possible.

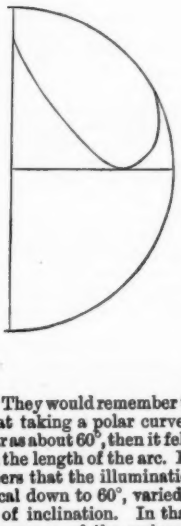
Mr. J. F. Albright said it must be a source of congratulation that they had had that paper put before them by Mr. Langdon, because that gentleman, he thought they would all agree with him, was, as it were, an impartial witness in the cause they most of them had at heart. A good many of them knew, or thought they knew, many of the facts Mr. Langdon had put before them in regard to cost, and so on, but they might have made them public many times, and they would not have produced the same effect as they had from the mouth of Mr. Langdon. He was not prepared to go into the history of electric lighting, or to tell them of a good many stations and depôts with which he had been connected in one way or another. What he proposed to do was simply to deal with the paper as far as he could deal with it as quickly as possible. In his opinion the great improvement in arc lamps, with which he thought everybody was acquainted, had created, and would create, a great opening for electric lighting in connection with goods yards and railway lighting generally. But he thought it was rather a mistake to overstate the advantages, and with every wish not to say anything unjust to the author of the paper, he thought it was a mistake to talk about a 10-ampère lamp as of 2,000 candle-power nominally. This was, in his opinion, misleading. Most of them knew that its actual candle-power, when placed in a globe or lantern, was not much in excess of 1,000 or 1,200 candle-power. There were many other points to which he might make allusion, and in regard to many of which he should be in agreement with the author; but the chief point he wished to touch upon was the question of the system to be adopted. The last speaker had dealt with that to some extent, and he dared say many of them would think, not unnaturally, that he would differ from him, for he believed the best system for large railway stations, stores and offices, &c., was the direct current system, whether they called it the three-wire system or the parallel system with a middle wire—for brevity he would call it the three-wire system—with 220 or 440 volts pressure. Whatever merits alternate currents might yet be proved to have, in small towns with extended areas, he believed that very few impartial engineers who, like himself, were equally interested in making alternating and direct current machinery, would advocate its adoption for such purposes as those which the author had put before them. He thought the very fact that the author had found it advisable to give in his appendix a set of rules for life-saving purposes to some extent justified his objection. He also, on somewhat similar grounds, was inclined to condemn high tension direct current series arc lighting, both on account of what he considered the needless danger of the system in such situations as they were discussing, and also because all lamps under that system, without considerable complication at any rate, had to be of practically the same size, whereas inside warehouses, under low-roofed stations, and in many other places, small arc lamps might be advisable. In other places he entirely agreed with Mr. Manville, large arc lamps were probably much the best. He did not know whether Mr. Manville meant to say that 12½ ampère lamps were first used at Portsmouth, or that he first used them. He (the speaker) might say that his firm had been in the habit of using 12½, 15, and even 20 arc lamps under similar conditions with favourable results. He believed 15 to 20 ampère arc lamps placed 50 to 60 feet above the ground in goods yards, and that class of space, were the best to adopt. Another reason for adopting the large units of light was that it was always difficult to find a place in those situations for arc lamp-posts, besides which, every extra lamp-post placed amongst rails added another chance of accident. With series arc lighting, supposing a waggon were derailed, or any similar accident occurred under many circumstances, this would extinguish by one blow 50 arc lamps, whereas by the three-wire system four to eight would be the maximum extinguished by one such accident. Returning to the question of the system to be adopted, he repeated that he believed in the three-wire 220 or 440-volt system, the latter for cases with extended areas. The very fact that they could now rely upon 220-volt incandescent lamps tended to make this system simplicity itself. It also enabled the requirements of the author (to which Mr. Manville had also alluded), namely, to have the whole of the operations of incandescent lighting and arc lighting, and the use of motors performed from one machine, to be easily fulfilled. At the same time he did not agree with the author if he meant that one machine, one single machine and one single engine, should be employed for such a piece of work as that. He thought certainly that there should be several such units besides what they might call the light load units. Another advantage of adopting such a system as he was advocating was that all sizes of lamps could be worked, 5, 7, 10 or 20-ampère lamps, according to the place in which they were situated. He thought it extremely probable, depending upon the requirements of every

case, that accumulators might be a very great improvement and benefit in addition to such a system as that. He believed generally that it would pay to introduce them, especially with the greatly reduced first cost of accumulators, which was now established. His idea of how passenger stations, goods yards, store sheds, &c., should be worked was with a low tension network laid throughout; and, in addition to the permanent lamps and motors, there should be a number of points at which plugs might be inserted for running portable arc lights, incandescent lamps, or motors, according to the requirements. This was not a mere idea on his part, for it was at the present time actually carried out in the East and West India Docks, and in the Royal Albert Docks. In the former, the system was adopted and carried out for a distance of 5 miles. He was informed that the cost of the conductors in this case was most carefully considered before the system was adopted, and it was after being worked out that it was found, on the question of conductors alone, that this system which he advocated was cheaper than the high tension system. In regard to cost of production, he believed, now, that cranes, capstans, winches, travellers, hoists, and all kinds of operations of that kind could be, and were being, worked electrically; they would be enabled to obtain a very fair day load in such situations as those to which Mr. Langdon had drawn attention, and his figures of costs of working, although they were certainly very good, might be cut down from 25 to 50 per cent. He thought this state of things would be realised, before they were very much older, in several of their chief railway stations and goods yards.

Mr. R. W. Weekes said, in reference to Table II. in Mr. Langdon's paper, they got the field exceedingly cheaply on the railways, and at the same time the machinery was well looked after, to keep the cost down; but when they looked at the labour item in the cost of production, he thought they found it was considerably higher than in any ordinary direct current station of an output almost in a line with that in the railway stations referred to. In the installation with which he was connected, as consulting engineer, where they used about 65,000 units per hour, and employed an Otto gas engine, the whole expense worked out to almost the average of those given by Mr. Langdon, *i.e.*, 2·96d., although the cost of gas worked out at 1·4d. per unit. Of course, the item on which they saved was the labour, although their charges for labour were by no means small. He had hoped they would hear from Mr. Langdon some information in connection with the train lighting gear with which he had experimented on the Midland Railway. He (the speaker) had abstracted and placed on the wall a few figures as to the cost of train lighting in America. These were taken from some information given by Mr. M. B. Leonard before some engineering society in America, and he believed they were reliable. He gave, in the first place, how much it cost to fit a train up, how much candle-power in each carriage, and, last of all, how much it cost to keep the light going. In the first example there was a high speed Westinghouse engine working on an Edison dynamo at a fairly high speed, and the cost worked out to £3 15s. for each lamp installed, and the upkeep cost, referred to in candle-power-hours, came out ·016d. as compared with oil, which was ·0206d., and the gas ·0306d. But in the gas system they had a larger number of small burners of 6 C.P. In the oil system the duplex burners were 12 C.P. After that an arrangement was given of a dynamo and accumulator of which the information was not so full but which came out at ·026. Then there was a Pullman Company's train without a dynamo, having only accumulators, which were withdrawn at the end of the journey to be recharged. This came out almost on a par with the last, and so did the next. Then was given a system, the same as that used on the Midland Railway, with a dynamo in the guard's van worked off the axle of the train. Mr. Leonard stated that the figures from which he worked out the cost were obtained after six months' working only, so they might not be absolutely correct. The cost was brought down as low as ·0117 per candle-power-hour, which was exceedingly low, as also was the first cost of installation which only came to £8 per lamp in the train, which, considering the exceptional character of the installation was not very large. He thought they would all be pleased if Mr. Langdon, in replying, would give a few figures of the cost on the Midland Railway, and if at the same time he obtained a higher candle power in each compartment than with the lights now in use in the place of the electric lamps.

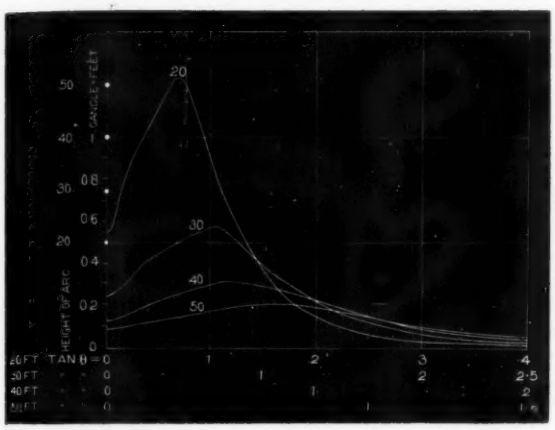
Captain Sankey called attention to the last column in Table II. It would be observed that in every case the cost of coal per unit was less for the half-year ending December than for the half-year ending June. That, no doubt, was due to the fact that the December half-year was a darker one than the June one, therefore the engines were better loaded, and the load factor was a higher one. Mr. Langdon had given two load curves for the Derby station, one for December 21st, and the other for June 24th. He (the speaker) had worked out what the cost of coal consumption ought to be for those two load curves; that was to say, on the supposition that the engines were worked in the manner most suited to the varying load. He was enabled to do this because he knew the consumption of these particular engines at every point of the load. The result came out thus: for the load curve for December the coal was ·23d. per unit, and for June it was ·84d. per unit. It was evident from that that an enormous difference was made by the load curve; the one in December was pretty good, and that in June exceedingly bad, and an engine, of course, was running the whole time. The average of those two figures was ·53; the average of the figures given by Mr. Langdon for Derby, ·65 and ·53, was ·59. It was very remarkable, he thought, that those figures should agree so nearly—that there should be so little difference in the actual working figures and those obtained by calculation. He thought the reason was that the station at Derby was looked after in a most exemplary manner. The engines were started, he felt sure, at the very moment they ought to be, and stopped at the very instant the load was sufficient to take off an engine. Anyone who saw that station would agree with him that it was a model for all electric lighting stations. The way in which those calculations were made he described, he thought, for the first time in some remarks he made on Mr. Crompton's Civil Engineer's paper on the cost of electric energy. Mr. Langdon had been kind enough to favour him with two load curves for one of the Birmingham stations, and he had calculated out what the consumption would be for those load curves on precisely the same lines, taking as the basis the consumption of a Willans simple engine, being the only consumption curve at his disposal for simple engines. For the December load curve, the heavier one, the cost came out ·26d., for July, which was still a comparatively heavy load curve, quite different from the June one at Derby, it came out at ·38d., an average of ·32d. In this station the majority of the lighting was arc lights, and therefore the load factor was a large one. The average of the figures given in Table II., and those at Lawley Street, was ·52d., a far greater difference between the calculated consumption and the actual. He could not, of course, give any reason for this, but probably at Birmingham the local conditions were not so favourable as at Derby.

Mr. A. P. Trotter said Mr. Langdon had given them a very lucid description of a plant producing a certain result. Station lighting, the lighting of goods yards, and so on, was one of the oldest applications of the arc light, and it was likely to be a very important one in the future also. But the result of all this work was *not* the putting down of so much plant—that was the result to the contractor—but the result to the company was the production of a certain amount of useful illumination. On that point Mr. Langdon did not give them much information, but he (the speaker) had been working out from Mr. Langdon's figures what he really was doing—that was to say, the actual result, viz., useful illumination. It was very important that they should know what was the illumination which was suitable for such purposes, as found by experience, in order that future contractors might be able to repeat the same result. For goods yards there were two purposes for which illumination was required. One was for reading the labels in transhipping the packages, and so on, and the other was for shunting. A comparatively small amount of illumination would do for shunting, so long as it was uniform and the lights were not dazzling; but they wanted better illumination for reading the labels, for the coefficient of men's handwriting came in. Mr. Langdon had given them a little information about the size of the lamps so far as ampères were concerned; but he did not say what the watts were. But the ampères and watts were only scientific information, compared with what Mr. Langdon really wanted in his goods yard. Even the candle-power was hardly worth while talking about. It was not that they wanted; they wanted the resulting illumination. The candle-power of an arc lamp varied in different directions, and for this purpose they must really consider that the candle-power of an arc lamp was different in different directions. This was a matter of simple calculation, and he would just refresh their memory by means of a diagram. From this he had deduced what



Mr. Langdon was doing. They would remember that in a paper read some time ago, he showed that taking a polar curve, a semicircle fitted the light of an arc lamp as far as about 60°, then it fell off; below that it went off, depending rather on the length of the arc. He had shown in a paper before the Civil Engineers that the illumination as far as this point, from 90° with the vertical down to 60°, varied as the fourth power of the cosine of the angle of inclination. In that paper he had worked out tables of the fourth power of the cosine, and from these it was easy to find out what the illumination must be at less angles than 60°. The tangent of 60° was 1·7; if they had two lamps, further apart than 3½ times the height of the lamps, this cosine law enabled the minimum illumination to be easily calculated. He had calculated many curves in which the horizontal scale was one of distance measured along the ground, and the vertical scale was illumination in "candle-feet," and observed many, by photometry in the City and other places. In his Civil Engineers' paper there were many curves of that sort, and they accorded well with the calculated curves. The question was, in some of these cases, whether they wanted the maximum or minimum. In a goods yard he should say the minimum illumination was the important thing to be observed. Mr. Llewellyn Preece, who was on Mr. Langdon's staff, communicated some calculations in an article in one of the journals in September, 1893, in which he had calculated the cos⁴ curves, and gave a diagram, from which it was easy to deduce the illumination of arc lamps from the distance apart. He had

recalculated such a diagram, and extended it to greater height. The dots showed lamps of 20, 30, and 40 feet high. The illuminations were plotted vertically, taking 20 feet as the unit height. The illumination fell off to something very small indeed at the middle point between the two lamps. This illumination was measured in candle-feet. If they increased the height of the lamp 1·5, to 30 feet in this case, they only got less than half the maximum illumination, but the minimum was considerably better. With a 40 feet post the maximum illumination was rather small compared with what it was with a 20 feet post, but it was quite good enough for any goods yard, and the minimum was better still. Finally at 50 feet, which was certainly very high for a good many purposes, the maximum illumination was reduced to about one-fifth, but it was spread over a large area and



there was a very good minimum. A 50 feet post would in most cases be out of the question of street lamps of course, but it would be very useful for goods yards. He had worked out the following figures from Mr. Langdon's data, he had taken the candle-power of the smaller lamp at 900. This was not a laboratory measurement but it was a liberal estimate for a 6·8 ampère arc in a lantern. He had often found street lamps with half that as deduced from the illumination.

Candle-power.	Height.	Distance.	Maximum.	Minimum.
	Feet.	Feet.	Candle feet.	Candle feet.
900	20	90	1·1	·206
1,500	20	120	1·85	·12
1,500	25	120	1·17	·153
1,500	40	120	·5	·28
900	40	120	·3	·168

The maximum illumination due to the 900 C.P. lamp on a 20 feet post was 1·1; about half a candle-foot was the best they got in the City; at least it was so at the time when he made his measurements. If they raised a 1,500 candle-power lamp to 25 feet they got about the same maximum, 1·17, and the minimum was increased to ·153. They wanted to attend to the minimum and let the maximum take care of itself. Dr. Preller had mentioned that a 40 feet post was a good thing, and said that posts of even 50 and 60 feet were used on the Continent, 80 or 90 feet apart. They had no need to go so far as the Continent for such lighting. At Nine Elms the posts were 50 feet high and 80 or 90 yards apart. That gave a ratio of 4·8 to 5·4 as the distance apart to the height of the lamps. That was an interesting old installation put up in 1881 with one dynamo to each lamp; they were Burgin machines, he believed, and had been running ever since. The ratio of the distance apart to the height was the really important matter. In such lighting as this the average was ·5, and taking Mr. Langdon's own figures for the Midland lighting, one ratio was 4·5; St. Pancras, 4·3; and the far end of the platform, 6·4, and so on. That was to say, the lamps were six times as far apart as they were high. It was pretty much the same in street lighting, which gave a fair distribution and a fair chance of getting a given minimum of light. The minimums in the street lighting as he had measured them were considerably lower than might be expected. In the City lighting, about half the whole area of the street was 0·1 of a candle foot; that was to say, more than half the street was worse lighted than the very minimum of that lighting; that was when the lamps were at their best. These observations were made in the winter of 1891-92. About one-quarter of the street only was better than 0·2 of a candle foot. The lighting of Whitehall by gas was just about the same. In Great George Street it never got up to ·1 anywhere. It was about ·02. That would not do for a shunting yard. One point in shunting was that it was very important to have a very high lamp-post to get rid of dazzling. Mr. Langdon apparently was satisfied with 20 feet, but he thought 40 feet would be much more suitable, and they then might have a bigger lamp.

Mr. Alexander Siemens said as they were on the point of height of lamps and distance apart, he might say that in 1879 they lighted the Royal Albert Docks with lamps of 28 ampères with an average of 80 feet high and 270 yards apart. The question of what height a lamp should be was an extremely simple one; it was a question of differential calculus—the maximum and minimum. The height ought to be about one-third of the distance between the lamp-posts, so as to get the maximum illumination in the centre of the space between the two posts.

Mr. Chamen said, on the question of lighting warehouses he would like to mention an arrangement of inverted arc lamps which was put into some of the sheds at Southampton docks at the suggestion of Mr. Aldridge. The shed first experimented upon was one through which the whole of the American Line passengers had to pass on embarking or disembarking, and a very great portion of the cargo was also handled in the same shed. It was first lighted with incandescent lamps; the light was complained of, and lamps of higher C.P. were put in; the light was still complained of, and still more lamps were put in. No satisfactory result, however, could be obtained. The roof of the shed was then whitewashed throughout, and 12 10-ampère inverted arc lamps were put up in place of the whole of the previous incandescent arrangement. The result was a considerable economy in current, the arc lamps using, if he recollected rightly, about half the amount of energy taken by the incandescents; the lighting, on the other hand, was everything that could be desired, the smallest writing on any of the labels on packing cases could be read with ease in any part the shed. The shed measured approximately 350 feet long by 120 feet wide, and the height from floor to principals was about 8 feet on the side where the trains came in, and he believed about 12 feet on the other side. It had since been decided to light some of the other sheds in the same way. On the question as to the system which should be employed to meet the conditions of general railway lighting, he certainly thought that a three-wire system at either 220 volts or 440 volts, or possibly even higher still, would be found to answer every requirement which Mr. Langdon could find, except, perhaps, that of lighting a long line of suburban railway stations, a thing which he believed, however, had not yet been done by any railway company. For such work as this he certainly thought that an arrangement of high pressure alternators and transformers, and possibly rectifiers also if any arc lamps were required, would be found the most economical arrangement. Mr. Langdon found a difficulty, which most people complained of, with regard to balancing the three-wire system. The difficulty was a real one, but in one large installation he knew of, by carrying the three-wire system into every place, and, where more than five lamps were in one room, into every room also, it was possible to keep the balance within about 20 ampères in a total of 1,100 or 1,200. He did not, however, suggest that it was possible to obtain an absolutely perfect balance, but mentioned this fact as he believed it to be about the best example of good balancing which could be shown. Some central station engineers reported that for days together they did not have to run their balancing sets, but then things suddenly altered, and without any notice they found themselves several hundred ampères out of balance. This, however, did not occur in the installation of which he was speaking. Referring to Mr. Langdon's load diagram at Derby, it might, perhaps, be interesting to the meeting to see the two diagrams of the Great Eastern Railway central station, which supplied Liverpool Street, Bishopsgate, and Bethnal Green stations, &c. By the kind permission of Mr. Wilson he was able to give them these diagrams. One diagram showed the different loads obtained on the various days in one week, viz., an ordinary week day, a Saturday and a Sunday in January. The ordinary week day was the full green line, the Saturday was the dotted green line, and the Sunday was the red line. It would be noticed that on Saturday at 5 o'clock the load did not reach its usual total of 2,600, but only came to 2,200, showing that the general offices were not consuming the usual amount of current. On Sunday a very marked difference was observable both in the morning and the evening. The sudden rise between 12 and 1 o'clock in the middle of the day, he believed, was caused by cloudy and dark weather coming on, otherwise he believed the load would not have risen on Sunday before about 3 o'clock, as on other days. The other diagram showed the alteration in the load diagram from time to time as the days got longer. The black line commenced January 1st, the dotted black line February 4th, and the blue line March 14th. He was unable to give a summer diagram, as only a part of the lights were connected last summer, and it would serve no useful purpose to give the load diagram at that time. Perhaps, as this installation had been referred to by Mr. Langdon, a brief description of it would be of interest. The plant consisted of four 200-H.P. sets and three 100-H.P. sets. It was, of course, at present much in excess of what was really required to drive the load, but the generating station had been completed before it had been possible to get all the lighting connected, and there still remained a considerable quantity of lighting to be done, part of which, however, was to be in buildings not yet erected. This plant was of a somewhat unusual type in this country, the 200 H.P. sets having armatures of 8 feet diameter, and 10 poles, and running at 120 revolutions per minute, direct-coupled to engines built by Messrs. Davey, Paxman & Co. The 100 H.P. sets were made with four poles, and ran at 150 revolutions per minute. Steam was supplied by five Davey-Paxman economic boilers. A large battery of accumulators, capable of giving about 1,000 ampère-hours discharge, and readily able to carry a discharge current of 200 ampères for some hours, or a very much larger current for a shorter time, was also supplied, and it was extremely probable that in the summer—on Sundays, at any rate—the plant would be entirely shut down for some hours during the day. In addition to this, the battery helped

materially by improving the engine load factor when the load happened to be too much for 100 H.P., and not enough for two; the battery could supply the difference, or, putting the thing another way, a 200 H.P. set could be run, and part of its power used for charging the battery. There would probably be a considerable difference between the Derby diagram and the Liverpool Street one in the summer months, arising from the fact that at Liverpool Street and Bishopsgate there were such a large number of places where light was required all day, no matter how bright the weather might be. Most of those places were absolutely underground. In some of them arc lamps burned continuously 24 hours per day, except Sundays. These were 32-hour lamps, and were fitted with a two-way switch and heavy current incandescent lamp, so that when it was necessary to re-carbon, the lamp trimmer switched the incandescent lamp into circuit and the arc out, and thus avoided groping about in the darkness, or the trouble of carrying a lantern to light him. The passenger station at Bishopsgate was also partly underground, and consequently was lighted during the whole of the day, and the light only went out after midnight until about 5 am. Mr. Langdon did not seem to have tried using larger lamps, placed higher, and using fewer of them; say 45 feet up, 15 ampères, and 100 to 110 yards apart. At the Crystal Palace there was a plant consisting of a Galloway engine capable of indicating somewhere about 130 H.P., and a Lancashire boiler. The engine drove three 550-volt compound dynamos by means of countershaft and belting. Each dynamo supplied 33 arc lamps, arranged in three circuits of 11 each. The lamps were suspended by means of hoisting gear from the 60-foot gallery, and were generally kept at a height of about 17 feet 6 inches from the ground. They were spaced about 56 feet apart, in two straight lines. The hours of lighting varied considerably, the longest run being seven hours, and the shortest 30 minutes, so that in summer more coal was wasted in getting up steam than was used in running the lights. The results of the year's working from October, 1893, to October, 1894, which had been given to him by Mr. Carr, chief engineer of the Crystal Palace, were as follows:—Total units generated, 45,584; total lamp hours, 82,880; cost of coal 19s. 6d. per ton; total cost per unit generated, including coal, oil, waste and petty stores, carbons, and all wages, 3s. 2d.; total cost per lamp hour, 1·77d. Taking into account depreciation, or rather redemption, reckoned on the original cost of the whole plant, some items at 10 per cent., and some at 5 per cent., but most at 10 per cent., the total cost per unit came to 5·21d., and the total cost per lamp hour 2·87d. Of course the efficiency of this plant was not so high as would be obtained with modern type direct-driven sets. The I.H.P. required to drive the 99 lamps was slightly under 100, whilst running the engine, countershafting belts and dynamos light, that was to say, with the brushes lifted, the indicator diagrams showed 22·5 H.P.

Mr. A. H. Preece said Mr. Langdon had referred in his paper to the installation of the Great Northern Railway Company, and he (the speaker) thought a brief description of what that company had done might be interesting to members. He would not go into details, as the time was short. They had practically installed there 1,317 indicated horse-power, a plant capable of lighting, including spares, 500 10-ampère arc lamps and 20,000 8-candle power glow lamps. The engines were Fowler's slow speed engines, driving Brush dynamos. The work of the dynamos, of which there were ten, one engine driving two, was for fifty lights each. The glow lighting dynamos were of three 100 and two 50 kilowatts. The circuits were altogether arranged over a length of seven miles. They had to deal with the problem of lighting an extensive narrow goods yard of seven miles in length, and it was utterly impossible to do anything but use the alternating current system. In this length they started from King's Cross Station and goods yard; they also lit the goods yards at Holloway and Finsbury Park, and they will light right down to Hornsey. Before long it would be extended to all suburban stations in that direction. At present there were 300 arc lamps installed and 7,000 glow lamps. The principal point of interest to members would be the costs. They had had a fair load on since July last, and their generating costs came out at an average of 2·67d. per unit, exclusive of carbons and cleaning arcs. The total came to 3·37d.; the interest and depreciation came to about 1d. a unit, which had to be added. From December to March, which was, of course, a heavy time for some time—the load was increasing every month—the costs had gone down to under 3d. per unit. He proposed to send in the details of the costs. The coal was about ·9d. per unit, and the wages, another big item, ·97d. per unit. As regards the wages, they were rather in a difficulty there because the station was under two heads, the locomotive department taking the engines and boilers, and the telegraph department taking the electrical part, the result being that they had two complete staffs in the station, which was not quite conducive to economical working. As regarded the height of the lamp posts and the distances apart, they do not, in putting the light in a goods yard, go into such figures as Mr. Trotter had quoted. In a goods yard they wanted light at certain points where the lines branched, and they had to put an arc lamp there, so that all over the yard the lamps were scattered about and a brilliant light was at the places where the crossing over took place. In the sheds they wanted as much light as possible. In the Great Northern sheds their lights were 16 feet high and 14 feet apart. In the goods yard they used 20 feet posts, 80 to 100 feet apart.

Mr. Langdon asked Mr. Preece how much depreciation came to per cent.

Mr. Preece said depreciation was nearly a half-penny a unit. They calculated it in rather a complicated way. They calculated 5 per cent. per annum on cables, trunking, and cost of lighting, then 2 per cent. on the buildings, and 2½ per cent. on the total capital expenditure for works' plant. That meant the running machinery and 5 per cent. per annum on the proportion of works' plant actually used during the week. It was a little complicated, but he thought it worked out in a very fair way. The last item of 5 per cent. was calculated by taking the proportion of plant hours that a station could possibly run to the proportion of plant hours it had actually run, and that fraction was taken as the capital cost of that plant. It worked out really at about 3 per cent. per annum. The total depreciation, therefore, amounted to about 5 per cent.

Mr. W. M. Mordey said he was afraid his nerves were in rather a shattered state, as he had nearly seen a ghost, the ghost of the dead low tension argument, rising in that hall. Mr. Langdon asked in the latter part of his paper what the future modes of distributing electricity would be for general purposes and for railway working. He imagined that Mr. A. H. Preece had just given them the information Mr. Langdon expected to receive, when he said it was not possible to carry out a broad scheme of lighting and distribution, such as they had in view at King's Cross, by any other than a high tension system. He supposed, as Bismarck said the other day, "we must either fight or fossilise;" so at the risk of opening a question most of them thought had closed, he must ask those interested in railway work to consider whether the future development would not be in some such direction as indicated by Mr. Preece, where not only the offices and the sidings and all the various parts of the railway system about the station were supplied from one generating station, but also the stations down the line, at any rate in all suburban or thickly populated districts. It was not possible, he thought, by any two or three-wire system to carry out work on a scale of that sort in any satisfactory way. If it were earlier in the evening he would like to take up this question of alternating currents, not as a question of alternating currents, but as a question of electrical engineering in its broadest aspect. There was no time to do that. He could only thank the author for the practical character of this paper, and particularly for the information regarding costs which he had given them. The arc lighting at the Great Northern station, and the arc lighting which Mr. Langdon had carried out, had been nearly all done on the series high tension system, and there was no doubt that system had many advantages. It did not require any arguments from him, because it had no competitor where they had to deal with arc lighting and arc lighting alone. He was an advocate of direct currents for arcs where they did not want a large amount of other work which could be done better in other ways. If the arc lighting was a comparatively small portion of a large scheme, then he thought the arc lighting should also be done by alternating currents or rectified alternators. Mr. Ferranti had been trying to introduce rectifiers for that work. He wished him success, not only for his own sake, but because it would enable them to combine the advantages of two systems. It would give them what some of them thought an advantage in arcs; it would give them a downward light. He was, however, getting a little shaky on this point. They always used to be taught that downward lights were an advantage, and it was said that alternating current arc lamps did not give that, nor, indeed, any light at all. He thought that idea was exploded now, but their principles were in danger of being shaken, for the advocates of the direct current were now telling them that the proper way was to turn the lamp the wrong way up, so that it sent all its light upwards. That, he supposed, was the coming style of direct current lighting. For the lighting of a large system for motor working as well as lighting, he thought could most satisfactorily be carried out by alternating currents.

Mr. Shoolbred said there was one point he was very much surprised that none of the speakers had referred to, that was the absence of any guarantee or safeguard against breakdown, in the shape of a duplicate plant, and that, to his mind, formed a very serious blot on the very fine work which Mr. Langdon had carried out. He himself had seen some of the stations to which Mr. Langdon had referred put into darkness for five or ten minutes, and that, he need hardly say, was a source not only of serious inconvenience, but of positive danger.

The President said the subject of the paper was one of very great interest to him, and he wished he had time to speak on it. He commenced his career at this kind of work—the lighting of railway stations. He supplied lamps to St. Enoch's Station in the very early days, when very few people dreamt of electric lighting. Mr. Siemens, Mr. Raworth, and himself, were engaged in railway lighting at very early periods, in fact King's Cross, Bricklayers' Arms, and St Enoch's, in 1881, so that railway electric lighting had reached a very respectable age by this time. There was one point which had not been touched on: what an enormous deal the railway men owed to electric light. He did not think it was known how great a saving of life had resulted from the adoption of electric lighting. Sir Myles Fenton had told him that the average saving of life at the Bricklayers' Arms Station had been several men per year. He thought that once that discovery had been made, the railway companies were to blame in not taking it up earlier than they did. Some large companies had not taken it up largely even now, and that fact which he had stated was known so long ago as 1880. He was not going to be tempted, even by Mr. Mordey, to go into the old subject of alternating currents. Mr. Mordey knew he was talking nonsense when he talked about either one thing or the other being dead. They would find the low tension people in this matter like old Brer Rabbit, they kept on "saying nuffin," because they knew they had got the best of it. Mr. Mordey could not have chosen a worse example than to suggest putting an alternating current into a goods yard. High pressure alternating currents were nasty things to deal with when the wires in a goods yard have fallen to the ground through a "pitch in" occurring, or any other accident knocking down the posts, and he thought it would be an absolutely sinful thing to put dangerous currents into such situations, and to add to the horrors and dangers of accident by the extinction of the lights at the same time. Mr. Trotter had really indicated one of the most important points in connection with this subject, after all one of the most important things to know was as to the proper height and the power of the lamps. He was quite in agreement with Mr. Siemens,

whose firm in the very early days hit on what had been really the best practice, which was also that of his own firm. Mr. Manville ought to know that 15 and 20 ampère lamps had been the rule and 10-ampère lamps the exception. Mr. Langdon only used 10 ampères, and smaller, because the plant came over from America equipped for that size. American practice was to use lamps of 10 ampères, but it was English practice long anterior to use 15 to 20 ampère lamps, 40 to 60 feet high. Nothing was so easy to do as an electric lighting installation for a railway station. It was extremely easily carried out on a simple system with 400 to 500 volts.

Mr. Langdon said the discussion had taken so wide a range that he questioned very much whether it was in his power at that hour to give a full reply to all that had been said. The paper which he had laid before them was one of a very unpretentious character in itself. It was chiefly a statement of what had been done by one of the larger railways in the kingdom with the object of applying the electric light to its traffic purposes. He thought they would join with him in saying that the results achieved showed how far-seeing and judicious had been the action of the Midland board in calling to their aid the electric light. The object of the paper had been to lay before, not only the members of the Institution, but others who might be interested in the question, what had been done, and also to ask assistance and advice from gentlemen who were advocates of various systems. The time no doubt was approaching when railway companies would have to make use of the electric light, and of electricity for other purposes besides lighting, to a very much greater extent than had been the case hitherto. They had up to the present laid down installations, as had been remarked, small installations hardly worth considering. In the future, in all probability, if the directors could see their way to encourage outlays of, perhaps, large sums, it would be necessary to adopt central stations, and to employ these central stations not only for lighting purposes, but for other purposes, such as traction or power, thereby economising the cost of the lighting. The lighting that was done and the power that would have to be used would have to be carried to considerable distances from those central points, five, six, or seven miles as might be. The installations which they had at Liverpool Street, Holloway, might, perhaps, be taken as a type of that which they would probably have to bring into use at such places. Hence the desire which he felt in submitting this paper of asking, as he had done, for suggestions upon the subject. He could not express sufficiently his thanks to those gentlemen who had contributed information. He would like to express his thanks to Mr. Raworth for the kind and complimentary manner in which he had referred to the Midland Railway Company. They were, of course, always very anxious to make their clients as comfortable as possible. They would be very glad at any time to offer facilities for the inspection of any of their installations, and he hoped if there were any who desired to examine them there would be no hesitation in asking to do so. He could not sufficiently express his thanks to Mr. Trotter for the admirable exposition he had given them as to the arrangement of the light. He felt, however, that the lighting of railway yards was somewhat different to that of lighting large areas. They wanted, as Mr. Preece had mentioned, to place the light in such a position that the men might have the full benefit of that light at that point, and he thought for that purpose the height they had chosen was about the best they could attain, and gave them about the best results for their purposes. Mr. Siemens had given them data upon which they might go in these matters, and Mr. Chamen had advocated the use of a three or a five-wire system. He scarcely felt himself competent at the present moment to offer any opinion upon those different systems; all he could say was that not only himself, but others, would read and study those observations with the greatest desire to make use of them in the interests of those they represented. He would answer all the points raised more fully in writing.

STORAGE BATTERY TESTING EXTRAORDINARY.

[COPY]

46, Queen Victoria Street, E.C.
March 21st, 1895.

H. Cuthbert Hall, A.I.E.E.
Report to J. Limbrey Higgs, Esq.

TESTS OF BATTERY MANUFACTURED BY THE INTERNATIONAL ELECTRIC STORAGE, LIMITED.

The battery consists of 11 cells, each cell having *one* positive and *two* negatives, the plates in question being five inches by six inches.

After several charges and discharges, with a view to bringing the battery into its normal working condition, it was discharged.

(*a*) At a rate 6½ times the maximum rate of an E.P.S. cell.

(*b*) At a rate 8⅝ times the maximum rate of an E.P.S. cell.

The capacity in the first instance was 3·4 times as great as would be obtained from an E.P.S. cell, discharging at its maximum rate $\left(\frac{1}{6{\cdot}25}\right.$ of the rate in question$\left.\right)$. The capacity in the second case was 2·77 times that of an E.P.S. cell of the same size, discharged at the maximum rate allowed by the makers $\left(\frac{1}{8{\cdot}75}\right.$ of the rate in question$\left.\right)$.

After these heavy discharges at rates which would tend to injure, and certainly temporarily to reduce the capacity of ordinary cells, the battery was discharged at 2½ times the maximum rate of an E.P.S. cell. The capacity obtained from this result was five times that of an ordinary E.P.S. cell discharging at the maximum rate $\left(\frac{1}{2{\cdot}25}\right.$ of the rate in question$\left.\right)$.

The cells were then again charged, and discharged at the same rate with a slightly better result than the one just quoted.

I am unable to make a comparison of the capacity of the International Storage Company's cells with the E.P.S. cells at the same rates of discharge as those employed in these tests, because the E.P.S. cell would not stand such heavy discharges, and if they were employed much lower capacities would result.

I have tested all kinds of cells, both experimental and on the market and have never found a cell which gave results even approaching these—results which I should not have credited had I not obtained them myself. Moreover, I have reason to believe that the I.S. cells can be discharged, without injury to their life and efficiency, to a very much greater fall of potential than that from which these results were deduced. For purposes of comparison, however, with cells on the market, the discharge was interrupted after the greatest fall of potential consistent with the life and efficiency of any cell known to the industry—the Waddell-Entz cell alone excepted.

The fact that the I.S. cells are capable of being worked at such high discharge rates would alone constitute them the most valuable cell for traction purposes extant: but in addition to this valuable quality they have at these high discharge rates, a capacity many times that of any known cell discharging at much lower rates. (*Note*: The capacity is to a certain extent dependent on the rate of discharge—the higher the discharge rate the lower the capacity.)

To summarise the advantages of the cell for traction purposes, it may be claimed that the I.S. accumulator has (1) a high rate of discharge per unit of weight, (2) a high capacity per unit weight, (3) such a construction as to suggest greater mechanical strength than any cell which depends for this feature upon a lead grid interspersed with active material, (4) the quality of permitting over discharging with less resultant injury than to other cells.

I give below the total weight of battery necessary for developing different powers for 19 hours.

5 H.P.	...	...	...	3 tons	6 cwt.	3 qrs.
7 „	...	...	...	4 „	13 „	2 „
10 „	...	...	...	6 „	13 „	2 „

The cells which I have allowed for in the above calculations would be quite capable of developing continuously a much higher power for a shorter period: or a normal rate of 5, 7 or 10 H.P., with occasional increases to much higher powers, for nearly 19 hours. For instance, the 5 H.P. battery would give an average of 5 H.P. for nearly 19 hours, and up to 10 H.P. for short periods of a few minutes throughout the run.

The type of battery advocated by the Electrical Power Storage Company for traction purposes to give 5 H.P. for 19 hours would weigh about 10 tons 15¼ cwt.

It should be noted that these tests are more valuable than those taken with isolated cells, as, by using a number of cells in series, working conditions are reproduced, and the results represent the capacity obtainable from the worst of the eleven cells.

H. CUTHBERT HALL.

NEW PATENTS—1895.

7,142. "Improvements in regulating transformers for alternating currents." MANCHESTER EDISON SWAN COMPANY, LIMITED, A. STILL, and E. W. COWAN. Dated April 8th. (*Complete.*)

7,147. "Improvements in telephone receivers." J. GRAHAM. Dated April 8th.

7,152. "Improvements in the mode of and means for writing by telegraphy, which he terms the pantelegraph." J. V. FABER. Dated April 8th. (*Complete.*)

7,191. "Improvements in electric arc lamps." H. J. FISHER. Dated April 8th.

7,245. "Improvements in electric railways." J. H. GUEST. Dated April 9th. (*Complete.*)

7,273. "Improvements in and in apparatus for the decomposition of alkaline nitrates." H. K. BAYNES and the CHEMICAL AND ELECTROLYTIC SYNDICATE, LIMITED. Dated April 9th.

7,278. "Improvements in or relating to electric conductors." C. H. GRAY. Dated April 9th.

7,310. "Improved means and apparatus for raising, lowering and traversing arc lamps used for photographic and other purposes." H. J. ROGERS. Dated April 10th.

7,315. "Improvements in and connected with electrical storage batteries." W. J. S. BARBER-STARKEY. Dated April 10th.

7,319. "Improvements in and relating to electrical hot plates." T. FLETCHER, W. RUSSELL and F. RUSSELL & Co., LIMITED. Dated April 10th.

7,364. "Improvements in the electrolytic manufacture of alkali-chlorates." J. WETTER. (Communicated by the Elektrizitäts-Aktiengesellschaft vormals Schuckert & Co., Germany.) Dated April 10th.

7,445. "Improvements in accumulators." D. E. HIPWELL. Dated April 11th.

7,458. "Improvements in the electrolysis of metallic salts," C. KELLNER. Dated April 11th.

7,504. "Improvements in and relating to the distribution of alternating currents." G. Ferraris and R. Arno. Dated April 13th.

7,525. "An electrical jacquard apparatus for use in curtain lace machines and fancy looms." W. Sissling. Dated April 13th.

7,548. "An electric safety switch." Siemens Bros. & Co., Limited. (Communicated by Messrs. Siemens & Halske, Germany.) Dated April 13th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

46. "Improvements in electrical apparatus for controlling traffic on single lines of railway." W. R. Sykes and A. G. Evans. Dated January 1st. The objects of the invention are to electrically control traffic on single lines of railway so that one or more trains may proceed, say from A to B, in succession, the second and succeeding trains not being delayed for the arrival of the first at B; on the other hand, although a succession of trains may proceed from A to B, no train can proceed from B to A until the last train despatched from A has arrived at B, and the visual signal or staff or its equivalent, which the driver carries, is inserted in its proper place in the staff instrument at B. 6 claims.

494. "Improvements in forges or furnaces for heating or working metals electrically." W. P. Thompson. (A communication by C. L. Coffin, of America.) Dated January 9th. Claims:—1. In an electric forge, the combination of a support, a refractory bed containing a coil of pipe, the end of which opens through said bed, means for forcing air, gas, or vapour, through said coil, and mechanism for maintaining a voltaic arc on said bed over the end of said pipe, substantially as shown and described. 2. In an electric forge, the combination of a support, a bed of refractory material, a coil of pipe located in said bed, and one end of which opens through said bed; a voltaic arc on said bed, a jacket of refractory material enclosing the arc, a magnet for deflecting the arc, and a resistance switch in the arc maintaining mechanism, substantially as shown and described.

546. "Improvements in electric telephony and telegraphy." A. Muirhead and G. W. Green. Dated January 10th. Consists in the use of a transformer with open magnetic circuit, having two or more primaries and a single secondary circuit wound concentrically on a core of iron wires. 5 claims.

1,087. "Improvements in methods for electric haulage." B. H. Thwaite and G. Cawley. Dated January 18th. According to the invention, in the case of canals or inland waterways, metallic standards or posts of wood are erected along the side of the canal or waterway, and to these standards or posts are affixed, one above the other, at convenient heights, two metallic beams or rails, of double angle or other suitable section. These beams or rails are metallically connected together, end to end, and made practically continuous along the whole length of the haulage system. The upper beam or rail is so arranged as to carry upon it an electric locomotive suitable for hauling a vessel, carriage or other vehicle, along the waterway or canal haulage track generally in one direction, and the lower beam is similarly arranged and adapted for carrying a like locomotive for hauling in the opposite direction. In order to prevent slipping of the locomotive wheels during the time of hauling, a suitable rack is affixed to each beam or rail, into which gears an equally-pitched pinion or pinions driven by an electric motor carried on the locomotive. In some cases grip pulleys, pressed together by a suitable spring or springs, may be used instead of the rack and pinions. 3 claims.

1,657. "A method of and apparatus for communicating electricity to vehicles." H. P. Holt. Dated January 25th. The inventor lays the conductor bare in a closed underground tube, supporting it at intervals on non-conducting carriers, the interval between one carrier and the next being preferably less than the length of the vehicle which has an iron or steel bar extending nearly its whole length, and near the ground immediately over the line on which the movable conductors are placed. Near the front end of this bar is fixed an electro-magnet of which the bar may form the armature or this bar may be magnetised in any convenient manner. 2 claims.

1,788. "Improvements in electric glow lamps." J. P. Bayly. (A communication from abroad by W. Wiklund, of Stockholm.) Dated January 27th. To prevent the carbon from leaning against or near the glass, is fixed inside through neck of lamp a small rod or wire, the carbon being threaded through a small loop or a hole in top end and made fast. This rod or wire can be made of glass or other suitable material, but when made of steel, iron, or other composition it will then collect or attract the residue from carbon thus ensuring clearness of glass on the inside. 3 claims.

1,810. "Improvements in electrical measuring instruments." H. E. S. Holt. Dated January 27th. Has reference to the vanes or needles of electrostatic instruments for commercial use, such as electrostatic voltmeters, and consists in perforating the metal of the vanes so that it is very much reduced in weight, and especially in moment of inertia, while the attraction remains sensibly the same. 2 claims.

2,548. "Improvements in firing keys or electrical contact makers." H. V. Keeson. Dated February 6th. The firing key consists of a vulcanite tube. In the middle of this tube is a metal plate, which is prepared for contact on both sides. Inside each end of the tube is a metal plunger or push which slides to and from the middle contact plate. The circuit is not closed until the two metal plungers are simultaneously touching the middle plate. For additional security these plungers or pushes are sunk or recessed below and inside the ends of the tube. 3 claims.

2,733. "Improvements in or relating to the regulating mechanism of electric arc lamps." W. C. Mountain and T. G. O'Brien Carew. Dated February 8th. Refers to improvements in or relating to the regulating mechanism of electric arc lamps, and has for its object simplicity of design, efficiency of action, and cheapness in manufacture. 2 claims.

2,965. "Improvements in holders for incandescent electric lamps." J. H. Geisenheiner and E. A. Lessing. Dated February 10th. The inventors provide within the holder a central contact with which a corresponding stud at the centre of the lamp-head is designed to make contact, and a side contact with which a ring contact surrounding the said stud contact is designed to come into contact, the third contact is formed by the socket into which the lamp-head is screwed. The leading-in wires are screwed to the said central and side contact and the return wire to the socket. 2 claims.

3,166. "Improvements in the conduit system of electric traction." J. B. Howard. (Communicated by W. Simon, W. Beissbarth, and J. Beissbarth, all of Nurnberg.) Dated February 14th. Consists of apparatus whereby the electrical current is received by a carriage which runs in an underground channel, and is thence conveyed to the electromotor mounted upon said carriage, and the drawing force of the motor depends upon the more or less strong contact of the latter, against the rails of contact. 4 claims.

3,426. "Improvements in electric lamps and in the holders or sockets therefor." D. Hunter and W. A. Jack. Dated February 17th. The inventors make the cap of the vacuum or other bulb of the incandescent lamp of vitrite, ebonite, or other hard or moderately hard insulating material, and the filament terminals which are embedded in the material are connected to preferably flattened contact pieces or strips. The cap is, as usual, provided with two projecting pins, which, when the lamp is fitted to the holder, lock into two bayonet joint slots cut in the shell or casing of the holder. When it is desired to switch on or off the electric current, all that is necessary is to merely turn the bulb or its cap partially round to either the right or left hand, so as to either move the filament terminal contacts against, and into contact with the plug contacts of the holder, or away from and out of contact with them. 2 claims.

4,235. "A new electric lamp fitting for pianofortes." J. W. Ewart. Dated February 28th. Consists of a solid base, to which is attached a tube bent in the shape of an inverted U, with one side produced and standing out, while the short end is fixed to the base. At the long end a piece of tube of smaller diameter is arranged to slide in and out of the larger tube, so that this may be still further produced as required, and at the end of the smaller tube an ordinary electric lamp with holder is fitted with a suitable shade or reflector. 2 claims.

8,654. "Improvements in apparatus used as brackets or chandeliers for electric light." R. N. Grenville and S. H. Terry. Dated May 2nd. Relates to the use of a flexible metallic tube or tubes of other material of a flexible yet self-sustaining character. 1 claim.

9,862. "Improvements in portable primary batteries." W. Morrison. Dated May 21st. Has for its object the provision of a battery, simple in construction, inexpensive in manufacture, and efficient in practical use.

13,749. "Improvements in electric signalling apparatus." C. A. Allison. (Communicated from abroad by the Standard Electric Signal Company, of New York.) Dated July 17th. In the system a central station or office is used, in which are located the working parts. 11 claims.

13,750. "Improvements in electric signalling apparatus. C. A. Allison. (Communicated from abroad by the Standard Electric Signal Company, of New York.) Dated July 17th. Relates to a modification of the apparatus described in specification 13,749. 3 claims.

14,602. "Improvements in controlling-apparatus for electromotors." J. B. G. A. Canet and A. Hillairet. Dated July 30th. Relates to means for controlling the working of electromotors used for operating bodies or machines such as elevators, winches, travelling bridges, ships' and other turrets, and tramway and railway vehicles, the movements of which are limited in extent and require to be reversed from time to time. 8 claims.

15,072. "A system of submarine signalling." L. J. Blake. Dated August 7th. An insulated cable is laid from the shore to a point near a lightship, where its core is electrically connected with the anchor of the ship. The anchor chain is in metallic connection with the sheathing of the vessel at the hawse pipe through which it is passed. Between the sheathing of the ship and a submerged plate held at a short distance from the ship's side a metallic circuit is established through a wire, to which is connected a telephone transmitter and a receiver of very low resistance. 2 claims.

17,313. "Improvements in and relating to electric motors." J. S. Losch, J. H. Phillips, J. W. Moyer, and J. H. Williams. Dated September 11th. Relates to electric motors of that class in which a series of radial armatures carried by a revolving shaft are caused to rotate in the field produced by a series of electro-magnets, the said electro-magnets being energised in succession through the action of a commutator carried by the armature-shaft in such manner that a series of impulses shall be exerted upon the radial armature in the direction of rotation of the shaft, and the arrangement of the parts being such that the total number of impulses so acting upon the armature during one revolution shall be equal to the number of field-coils multiplied by the number of armature-sections. 6 claims.